Engineering Library

The Engineer.

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THE ENGINEER.

PLEASE MAKE A RECORD THAT ALL FUTURE COMMUNICATIONS SHOULD BE ADDRESSED TO:—

28, ESSEX STREET, STRAND, LONDON, W.C. 2.

The Engineer

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PUBLIC NOTICES

HEATING.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Wednesday, 4th June, 1930, for ACCELERATED LOW-PRESSURE HOT WATER HEATING, &c., at the Head Post Office, Hull.

Drawings, specification, and a copy of the conditions of and form of contract, bills of quantities and forms for Tender may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to the Commissioners, H.M. Office of Works.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 5016

HEATING.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Thursday, 5th June, 1930, for ACCELERATED LOW-PRESSURE HOT WATER HEATING, &c., at the County Court, Clerkenwell.

Drawings, specification, a copy of the conditions and form of contract, bills of quantities and forms for Tender may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to the Commissioners, H.M. Office of Works.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 4995

HEATING.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Thursday, 29th May, 1930, for the INSTALLATION of HEATING, &c., at (A) H.M. Treasury, Whitehall, S.W.; (B) the County Court, Clerkenwell, N.

Drawings, specification, copies of the conditions and forms of contract, bills of quantities and forms for Tender may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to the Commissioners, H.M. Office of Works.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 4996

Civil Service Commission.

FORTHCOMING EXAMINATION :—PROBATIONARY ASSISTANT ENGINEERS in the Engineering Department of the Post Office (20-25, with extension in certain cases).

Regulations and particulars, together with the forms on which applications must be made, will be sent in response to requests (preferably by postcard), addressed to the SECRETARY, Civil Service Commission, Burlington-gardens, London, W. 1, giving the title of the situation. The latest date for the receipt of application forms is 10th July. 4994

Crown Agents for the Colonies.

COLONIAL GOVERNMENT APPOINTMENTS.

APPLICATIONS from qualified candidates are INVITED for the following POSTS :—

M/2015.—ASSISTANT ENGINEERS (12) REQUIRED by the GOVERNMENT of NIGERIA for the PUBLIC WORKS DEPARTMENT, for two tours of not less than 12 nor more than 18 months' service in the first instance. Subject to satisfactory service, the officers appointed will be eligible at the expiration of three years' service for confirmation in the permanent and pensionable establishment. Salary, £480 a year for the first three years; then £510, rising by annual increments to £920. Outfit allowance of £60 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates must have attained the age of 21½ years on the date of appointment, and should preferably have attained the age of 22½ and must not be over 35 years of age. Must have obtained an Engineering Degree at a recognised University or have passed Sections "A" and "B" of the A.M.I.C.E. Examination or have passed the Associateship in Civil Engineering of the City and Guilds Institute, or possess such other Degree or Diploma or Distinction in Engineering as may be considered satisfactory. Candidates whose qualifying diplomas have been obtained without a College course should have had three years' practical experience of Civil Engineering under a qualified Civil Engineer. It is preferred that all candidates should have had two years' practical experience on good Engineering Work subsequent to taking their degree or completing their articles, but under certain conditions this may be waived in the case of candidates in possession of an Engineering Degree.

M/1975.—ASSISTANT ARCHITECT REQUIRED by the GOVERNMENT of NIGERIA, for two tours of 12 to 18 months' service, and possible extension. Salary, £480 a year for the first three years, then £510, rising to £720 a year by annual increments of £30, and thence rising to £920 a year by annual increments of £40. Outfit allowance of £60 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, 25 to 35 years of age, should be A.R.I.B.A., or hold some equivalent Diploma. Should have had Architectural Experience in a Municipal, County or similar office.

M/2148.—ASSISTANT ENGINEER REQUIRED by the GOVERNMENT of ZANZIBAR PUBLIC WORKS DEPARTMENT for a tour of 20-30 months' service and possible extension. Salary, £480, rising to £600 a year by annual increments of £20, and thence rising to £720 a year by annual increments of £30. Free quarters and passages and liberal leave on full salary. Candidates, 25 to 28 years of age, preferably unmarried, must have passed Sections A and B of the Examinations of the Inst. C.E. or hold professional qualifications recognised by that Institution as exempting from those examinations, and have had general Civil Engineering Experience, preferably in Road Construction, Building and Waterworks.

M/2065.—ASSISTANT ENGINEER REQUIRED by the GOVERNMENT of TANGANYIKA TERRITORY for Roads Construction, for a tour of 20 to 30 months' service. Salary, £480 to £600 a year, according to experience and qualifications. Outfit allowance of £30 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, 28-35 years of age, must have had experience of Railway or Road Contracting Engineer's Work Abroad. Must be able to undertake the Construction of Earth and Gravelled Roads, including Earthworks, Steel, Reinforced Concrete and Timber Bridges and auxiliary works. Preferably should have had experience of Survey and Location Works, and preferably should be Associate Members of the Institution of Civil Engineers.

Apply at once by letter, stating age, whether married or single, and full particulars of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting the reference number against the appointment for which application is made. 5037

PUBLIC NOTICES

Royal Corps of Naval Constructors.

A COMPETITIVE EXAMINATION for a POST as PROBATIONARY ASSISTANT CONSTRUCTOR will be held at the Royal Naval College, Greenwich, during the first fortnight in July next.

Candidates must not be more than 24 years of age on 1st October next, and must then have been engaged in practical shipbuilding work for at least 18 months. Graduates from the Universities are preferred.

The salaries and other conditions of service are given in full in the regulations of the Royal Corps of Naval Constructors. The salaries during the two or three years' Greenwich course, including cost-of-living bonus reckoned at its present rate of 70, are approximately as follows :—

Probationary Assistant Constructors on joining R.N. College, £190 in addition to mess allowance.
Probationary Assistant Constructors during second half of course, £220 in addition to mess allowance.

Candidates successful at the end of the R.N. College Course will be admitted into the Royal Corps of Naval Constructors as permanent Civil Servants, with corresponding superannuation and other privileges; the salaries, including bonus as above, of the lower grades being approximately as follows :—

2nd Class Assistant Constructor (first 3 years), £320-£360.
1st Class Assistant Constructor (after 3 years), £430, rising to £710.

The salaries, &c., for the higher grades are stated in the regulations, which may be obtained from the SECRETARY OF THE ADMIRALTY (C.E. Branch), Whitehall, S.W. 1, to whom intending candidates must submit their names and full particulars of their educational and technical training and practical experience not later than Monday, the 26th instant. PRIVATE STUDENTS OF NAVAL ARCHITECTURE.

A QUALIFYING EXAMINATION will be held in conjunction with the above, for the admission to the Royal Naval College, Greenwich, of PRIVATE STUDENTS of NAVAL ARCHITECTURE who desire to receive instruction in the course laid down for PROBATIONARY ASSISTANT CONSTRUCTOR.

Applications for admission as Private Students should reach the SECRETARY OF THE ADMIRALTY (C.E. Branch) not later than the 26th instant.

Private students are required to pay a fee of £50 per session.

Applications for the regulations should be accompanied by an addressed foolscap envelope. 4960

PUBLIC NOTICES

Mechanical and Electrical Engineering Assistant, Grade III., age 25 to 30, with general workshop or similar experience, capable of working up and preparing plans of machinery layouts, electricity and water mains, and general mechanical engineering details, required in Air Ministry, Works and Buildings Directorate. Salary scale is £140—£7 10s.—£200 p.a. plus bonus. Bonus on £140 p.a. is at present £79 13s.; the commencing salary will therefore be £219 13s. p.a.

Applications should reach the SECRETARY, Air Ministry (W.B. 5), Kingsway, London, W.C. 2, by 31st May, 1930. 5035

Vacancies for Civilian STATION ENGINEERS, GRADE II., AT ROYAL AIR FORCE STATIONS.

APPLICATIONS for these POSTS are INVITED from candidates between 30 and 45 years of age, who have had a sound practical training in mechanical or electrical engineering, with experience of the running and repair of generating, pumping and heating plants, and machine tools, and the installation of overhead and underground mains and wiring for electricity.

Preference will be given to ex-Service men and to candidates with experience in the control of staff.

The scale of salary is £175 per annum, rising by £10 per annum, if satisfactory service is given, to £225 per annum, plus Civil Service bonus. The bonus on £175 p.a. is £90 19s. p.a., but it is subject to revision in relation to the cost of living; the commencing salary will therefore be £265 19s. p.a. in all.

Selected candidates will be medically examined and, if found suitable, will be appointed to a home station, but they may be required to undertake tours of duty at foreign stations periodically; whilst serving abroad they will be entitled to additional monetary allowances.

If satisfactory service is given, station engineers, Grade II., are eligible for appointment to pensionable posts, and also to promotion to station engineer, Grade I., as vacancies arise.

Forms of application may be obtained from the SECRETARY (W.B. 5), Air Ministry, Adastral House, Kingsway, London, W.C. 2, and should be returned completed on or before the 31st May, 1930. 5035

PUBLIC NOTICES

India Store Department.

APPLICANTS are informed that the POSTS of MAINTENANCE ENGINEER and ASSISTANT ENGINEER INSPECTOR have now been FILLED. 5018

The University of Liverpool.

FACULTY OF ENGINEERING.

APPLICATIONS are INVITED for the POST of JUNIOR LECTURER in the Department of Civil Engineering. Salary £300 per annum. Experience in Municipal Engineering desirable.

Applications, accompanied by copies of not more than three testimonials, should be received on or before June 10th, 1930.

Particulars and conditions of the appointment may be obtained on application to the REGISTRAR. 5038

University College of Swansea.

The Council invites APPLICATIONS for the POST of ASSISTANT LECTURER in the Department of Metallurgy. Salary £300 per annum. The appointment will date from the 1st September, 1930.

Further particulars may be obtained from the undersigned, by whom applications must be received on or before the 28th May, 1930.

EDWIN DREW, Registrar.
Singleton Park, Swansea. 4962

Witwatersrand Technical College.

JOHANNESBURG, SOUTH AFRICA.

APPLICATIONS are INVITED for the POST of LECTURER-IN-CHARGE at an important Branch of the College near Johannesburg. A regular training in engineering, including workshop practice, is essential. Applicants must also be graduates or possess equivalent qualifications. Personality, organising ability and initiative and previous lecturing experience will be recommendations.

Salary scale £450-25-£650 plus local allowance. Local allowances: in the case of a married officer, £66 to £76; single officer, half these amounts. The appointment is full time and includes both day and evening work. An allowance of £60 will be made towards travelling expenses, with half salary from date of sailing to date of arrival in Johannesburg.

The initial salary may be fixed according to existing salary, qualifications and experience of the successful applicant, who will be required to join the Government Provident Fund.

Applications in duplicate, giving full particulars of training and experience, must be submitted on or before the 21st May, 1930, to Messrs. CHALMERS and GUTHRIE (MERCHANTS), Ltd., 9, Idol-lane, London, E.C. 3, from whom conditions of service and special application forms may be obtained. 4977

Armourers' and Brasiers' Company.

LECTURES IN METALLURGY.

The Company have arranged for the following LECTURES to be delivered :—

At the Institution of Electrical Engineers, Savoy-place, Victoria Embankment, W.C. 2, at 5.30 p.m. on 21st May, 28th May and 4th June, 1930, by J. FERDINAND KAYSER, Esq., Assoc. Met., on "PERMANENT MAGNETS AND MAGNET STEELS."

At the Sir John Cass Technical Institute, 31, Jewry-street, Aldgate, E.C. 3, at 7 p.m. on 27th May, 3rd June, and 10th June, 1930, by GEO. PATCHIN, Esq., A.R.S.M., M. Inst. M.M., on "MICRO-EXAMINATION OF ENGINEERING METALS AND ALLOYS."

ADMISSION FREE, WITHOUT TICKET. 4997

South Indian Railway Company, LIMITED.

The Directors are prepared to receive TENDERS for the SUPPLY of :—

SIGNALLING AND INTERLOCKING MATERIALS (ii.).

Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tender for Signalling and Interlocking Materials (ii.)," with the name of the firm tendering, must be left with the undersigned not later than Twelve Noon on Friday, the 30th May, 1930.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of £1 for each copy of the specification.

Copies of the drawings may be obtained at the offices of the Company's Consulting Engineers, Messrs. Robert White and Partners, 3, Victoria-street, Westminster, S.W. 1.

A. MUIRHEAD, Managing Director.
91, Petty France, Westminster, S.W. 1.
14th May, 1930. 5039

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PUBLIC NOTICES

Administrative County of LONDON.

The London County Council invites TENDERS for the CLEANING, REPAINTING, &c., of :—
(1) HIGHGATE ARCHWAY ;
(2) The BRIDGE CARRYING the SOUTHERN RAILWAY over TOWER BRIDGE-ROAD.

The specifications, forms of contract and Tender, bills of quantities, &c., may be obtained on application to the Chief Engineer, Old County Hall, Spring-gardens, S.W. 1, upon payment in each case of £1 by cheque, draft or money order, to the order of the London County Council. This amount will be returnable only if the tenderer shall have sent in a bona fide Tender and shall not have withdrawn the same. Full particulars of the work may be obtained on personal application, and the contract documents may be inspected before payment of the fee.

Remittances by post should be addressed to the Chief Engineer, Old County Hall, Spring-gardens, S.W. 1. Personal enquiries at Room 3A, No. 3, Warwick House-street, Cockspur-street, S.W. 1.

The contractor will be bound to observe the provisions of a fair wages clause, the terms of which are set out fully in the instructions for Tender and form of contract and in "The London County Council Gazette."

No Tender received by the Clerk of the Council at the County Hall, Westminster Bridge, S.E. 1, after 4 p.m. on Monday, 2nd June, 1930, will be considered.

The Council does not bind itself to accept the lowest or any Tender.

MONTAGU H. COX,
5024 Clerk of the London County Council.

Bengal-Nagpur Railway COMPANY, LIMITED.

The Directors are prepared to receive TENDERS for :
2100 DRAW-BARS.

Specification and form of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, London, E.C. 2, on or after Monday, 12th May, 1930.

A fee of 10s. will be charged for each copy of the specification, which is NOT returnable.

Tenders must be submitted not later than Noon on Friday, 23rd May, 1930.

The Directors do not bind themselves to accept the lowest or any Tender, and reserve to themselves the right of reducing or dividing the order.

By order of the Board,
R. GRANT,
4999 Secretary.

Bombay, Baroda and Central INDIA RAILWAY CO.

The Directors are prepared to receive up to Noon on Wednesday, 4th June, TENDERS for the SUPPLY of :
BOLTS, NUTS AND RIVETS, &c.

Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 10s. each (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG,
Secretary.

Offices : The White Mansion,
91, Petty France, Westminster, S.W. 1,
13th May, 1930. 5015

City and Royal Burgh of DUNDEE—ELECTRICITY DEPARTMENT.

The Corporation invites TENDERS for the SUPPLY and LAYING of approximately 655 FEET of 42in. diameter CAST IRON SPIGOT and FAUCET PIPING. The excavation work and the construction of the foundation for the pipes will be executed under another contract.

Specification, schedule of quantities, form of Tender and general conditions of contract and drawings may be obtained from the undersigned on payment of a deposit of £2 2s., which sum will be returned upon receipt of a bona fide Tender.

Tenders (sealed in envelopes provided) must be lodged with W. H. Blyth Martin, Esq., Town Clerk, City Chambers, Dundee, not later than by Thursday, 12th June, 1930.

The Corporation does not bind itself to accept the lowest or any Tender.

D. R. BISHOP, B.Sc., M.I.E.E.,
General Manager and Engineer.
Electricity Supply Department,
Dudhope Crescent-road, Dundee,
13th May, 1930. 5031

Upper Stour Valley Main SEWERAGE BOARD. PUMPING PLANT.

The above Board invite TENDERS for the SUPPLY, DELIVERY and SETTING TO WORK of a TREBLE-RAM PUMP capable of delivering 15,000 gallons per hour, ELECTRIC MOTOR and AUTOMATIC CONTROL GEAR, together with all ACCESSORIES to make the plant complete.

Copy of particulars and Tender form may be obtained from the Engineer, Mr. G. P. Deeley, M. Inst. M. and Cy. E., 13, Church-street, Stourbridge, on and after Monday, May 19th, on payment to the undersigned of £1 1s., which sum will be returned on the receipt of a bona fide Tender on the form provided.

Sealed Tenders, endorsed "Tender for Pumping Plant," to be delivered at my office not later than Noon on Saturday, the 31st May next.

The Board do not bind theselves to accept the lowest or any Tender.

By Order,
GEORGE GREEN,
Clerk to the Board.
High-street, Cradley Heath, Staffs.,
May 9th, 1930. 5010

Adminstrative County of LONDON.

The London County Council REQUIRES, as soon as possible, a FULL-TIME ENGINEERING WORKSHOP INSTRUCTOR at the School of Engineering and Navigation, High-street, Poplar, E. 14, to teach workshop practice and theory to students aged 13 to 21 (day and evening). Wide workshop experience, including repetition work, is essential, setting up and work of progress department would be an advantage. Salary £290-£14-£410. To be eligible for the Instructors' scale, candidates must have had five years' industrial experience after the age of twenty-one years. The first increment accrues after two years' teaching service. Commencing salary will be according to experience.

Apply, Education Officer (T.1), the County Hall, S.E. 1 (stamped addressed foolscap envelope necessary), for form, to be returned by 26th May. Canvassing disqualifies.

MONTAGU H. COX,
5003 Clerk of the London County Council.

Broadstairs and St. Peters URBAN DISTRICT COUNCIL. WATERWORKS DEPARTMENT. STATION ENGINEER.

The above-named Council invite APPLICATIONS for the APPOINTMENT of STATION ENGINEER, in Charge of their Pumping Station at Rumfield, St. Peters.

Applicants must be competent to Take Charge of the Pumping Plant, which includes Vertical Oil Engines, Deep-well Pumps, Softening Apparatus, &c.; and have had practical workshop experience, as the person appointed will be responsible for carrying out all running repairs.

The salary is £250 per annum, rising by annual increments of £20 to a maximum salary of £350 per annum, payable monthly. A small house adjoining the pumping station will be provided rent free.

Applications, which must be made on a form obtainable from the undersigned, must reach me not later than 29th May, 1930.

E. F. OWEN,
Clerk to the Council.
Pierremont Hall,
Broadstairs,
May 15th, 1930. 5041

LEASE OF IMPOSING OFFICES FOR SALE.
33, NORFOLK STREET, STRAND, W.C. 2.

In consequence of the recent amalgamation of "THE ENGINEER" LTD., proprietors of "The Engineer," with MORGAN BROS. (PUBLISHERS) LTD., proprietors of "The Ironmonger" and "The Chemist & Druggist," the offices of the three journals will shortly be transferred to new and more commodious freehold premises which have been acquired at 28-31, Essex Street, Strand, W.C. 2.

The remainder of the lease, covering a further twenty-five years, of the present offices of "The Engineer" at 33, Norfolk Street, Strand, W.C. 2, is in consequence for sale. This particularly well lighted five-storey building has an area of 8,200 sq. ft., and occupies a site at the corner of Norfolk and Howard Streets, adjacent to the Temple Station, whence Westminster and the City may be reached in a few minutes. The building is of modern construction and has a fine and distinctive elevation. It is in good order throughout, and vacant possession can be had in June next. Rent £1,600. Moderate price. For further particulars apply to :—

WHATLEY, HILL & CO.,
24, Ryder Street, St. James', S.W. 1.

LEASE OF IMPORTANT CITY OFFICES FOR SALE.
42, CANNON STREET, E.C. 4.

In consequence of the recent amalgamation of Messrs. MORGAN BROTHERS (PUBLISHERS) LTD., proprietors of "THE IRONMONGER" and "THE CHEMIST AND DRUGGIST," with THE ENGINEER, LTD., proprietors of "THE ENGINEER," the offices of the three journals have been moved to new and more commodious freehold premises which have been acquired at 28-31, Essex-street, Strand, W.C. 2.
The lease of the entire premises, of which the four well-lighted upper floors have been in occupation of Morgan Brothers (Publishers) Ltd., the Ground Floor and Basement being sub-let to the Aerated Bread Co., Ltd., is in consequence for sale.
Alternatively, the four upper floors (which have also an entrance to Garlick Hill), having a total area of about 7,000 sq. ft. would be let.
The premises are in good order and vacant possession can be had in June next. Rent £2,000 per annum, inclusive of rates.

For further particulars apply to :

Messrs. FAREBROTHER, ELLIS & CO.,
29, Fleet Street, E.C. 4.

PUBLIC NOTICES

Mersey Docks and Harbour BOARD.

TWO DRAUGHTSMEN, fully experienced in the work of a Dock Engineer's Office and preferably with a knowledge of Mechanical Engineering.

Applicants should furnish full details of their experience, positions held, age, and salary desired.

Address, ENGINEER-IN-CHIEF, Dock Offices, Liverpool. 5032

International Prize Competition for a Road-bridge over Lake Malaren in Stockholm.

RESULTS OF THE COMPETITION.

The prize jury has decided to award 4 prizes to the designers of the following projects :—

1. PRIZE, 12,000 SW. CR.—Motto "Brugg," designers, W. Maelzer, civil engineer, arcnitects Professor Salvisberg and Professor Buning, Berlin.
2. PRIZE, 10,000 SW. CR.—Motto "Im Fels verspannt," designers, Professor E. Gabel, Karlsruhe, and architect H. Esch, Mannheim.
3. PRIZE, 9000 SW. CR.—Motto "Tva Bagar," designers, Maschinenfabrik Augsburg-Nurnberg, Mainz, P. Holzmann, Ltd., Frankfurt, architects F. Hedqvist and D. Dahl, Stockholm.
4. PRIZE, 7000 SW. CR.—Motto "Ungleiche Bogen," designers, Doctor-Eng. R. Farber, Breslau, and architect A. Schuhmacher, Stuttgart.

And to purchase the following three projects :—

1. Motto "NORR-SODER," designers, Professor K. Ljungberg and architect C. Johansson, Stockholm.
2. Motto "FRI SIKT," designers, Maschinenfabrik Augsburg-Nurnberg, Mainz, P. Holzmann, Ltd., Frankfurt, architects P. Hedqvist and D. Dahl, Stockholm.
3. Motto "STAHL OCH BETONG," designers Doctor-Eng. F. Emperger, architects R. Hirsch and F. Stiurm, Vienna.

The projects will be on view at 23, Storgatan, Stockholm, from the 7th of May until the 8th of June, 1930, daily between 9 and 19 o'clock.

5011 THE HARBOUR BOARD.

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED for Factory in Borneo, ASSISTANT ENGINEER, with experience Steam Plants ; public school man, age 22/25. Commencing salary £400, outfit allowance, annual increases.—Address, stating qualifications and references, P7012, The Engineer Office. P7012 A

WANTED in London, REPRESENTATIVES with technical experience for sale of Brickmaking Plant, Moulds and Machinery for Cement Articles, Steel Window Frames, Shutters, High-pressure Lubricators, Welding, Cutting and Soldering Apparatus, Automatic Filling and Closing Machines for Pharmaceutical Products, &c.

Commission and reasonable expenses. Would suit man already representing allied but non-competing lines.

Address, stating age, experience, and references, P7026, The Engineer Office. P7026 A

CAPABLE ENGINEER, Age 30-35, WANTED AT ONCE for important Coke Oven contract on the Continent. Knowledge of French essential. State salary required and when disengaged.—Address, P7027, The Engineer Office. P7027 A

CONSTRUCTIONAL STEEL WORK DESIGNER REQUIRED for London Consulting Engineer's Office. Must be conversant with requirements of 1909 Building Act. State experience and salary expected.—Address, P7011, The Engineer Office. P7011 A

SITUATIONS OPEN (continued)

ENGINEER.—ENGINEER REQUIRED for Petroleum Refinery in Burma. Single man, not over 25. Good general practical mechanical training. Drawing-office experience a recommendation.—Write, stating age, with full particulars of qualifications and indication of salary required, to Z.P. 904, c/o Deacon's Advertising Agency, Fenchurch-avenue, London. 5030 A

ESTIMATOR WANTED, with Experience in Estimating for Boilers and Boiler-house Plant.—Apply by letter, stating age, experience and salary required, H. and T. DANKS, Netherton, Ltd., Netherton, Dudley. 504 A

FIRST-CLASS MAN WANTED, to Take Charge of and be Responsible for Section of Drawing-office in well-established firm. Must be capable of dealing efficiently with all matters relative to engines being manufactured. Considerable experience on High-speed Aircraft Engines essential.—Address, stating age, full experience, and salary required, 5004, The Engineer Office. 5004 A

HARBOUR ENGINEER.
WANTED, ENGINEER, age about 40, able construct Reinforced Concrete Jetties and maintain Works, Plant and Equipment for Small Harbour in Tropics. Must have had similar experience and accustomed under-water inspections.
Knowledge Spanish and good medical record essential. Progressive position. Send full particulars training, experience, salary required, and copies testimonials.—Address, P6989, The Engineer Office. P6989 A

MALE SHORTHAND TYPIST (Not Over 25) REQUIRED for German correspondence in Machine Tool Maker's Office. Good prospects for intelligent young man.—Write, stating age, speeds, experience, salary required, and enclosing testimonials, HENRY PELS and CO., Ltd., 32, Osnaburgh-street, N.W. 1. P7014 A

MANAGER REQUIRED for Engineering Works in East Anglia. Applicants must be under forty years of age and fully conversant with latest methods of production and control. Works have machine, fitting, blating shops and foundry, employing 150 to 200 men and rapidly expanding. Progressive appointment to right man.—Address, stating experience and salary required, 5023, The Engineer Office. 5023 A

PLANNING AND RATE FIXING.—First-class MEN REQUIRED ; must have rate fixing experience on Car or Commercial Vehicle work and be able to schedule times from drawings. Liberal salary to right men.—Address, giving fullest particulars, 5034, The Engineer Office. 5034 A

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For continuation of Small Advertisements see page 4.

A Seven-Day Journal

Trades Unions and Rationalisation.

THE attitude of certain trades union leaders towards rationalisation was made clear at two meetings held during the week. Mr. Sherwood, in his presidential address to the Federation of Engineering and Shipbuilding Trades, referred to the recent establishment of the company known as National Shipbuilders' Security, Ltd., and described it as a scheme to protect the profits of shipbuilders and repairers and as a menace to the workpeople. It would mean, he said, the closing down of redundant shipyards so as to safeguard the employers without regard to the interests of those who had by apprenticeship and training learned their craft in the shipbuilding industry. The movement, he urged, must be met by strong collective action. The trades unions must compel the shipbuilding employers to realise that the workers displaced by the closing of redundant yards were entitled either to compensation for the loss of their employment or to alternative employment without loss of status or income. He recommended that negotiations should be opened immediately with the employers with the object of finding a basis for the removal of the menace. Rationalisation was also discussed during the week by the National Council of the Amalgamated Engineering Union. The discussion arose on the movement of a resolution to the effect that the executive council should collect and lay before the members all the available information on the subject of rationalisation in order that they might be placed in a position to appreciate its dangers and in order that the executive might be able to formulate a policy to meet the situation. The resolution was carried by a large majority. Most of those who took part in the discussion attacked rationalisation on the score that it would lead to unemployment and the dilution of labour, intensify the exploitation of the workers and lower the standard of living.

Large River and Harbour Dredging Contracts.

A SOUTHAMPTON firm—the James Dredging, Towage and Transport Company, Ltd., which is now carrying out important dredging and reclamation work in connection with the construction of the new docks at Southampton—has recently secured in the face of severe competition the order for the dredging of the river Bann, in Northern Ireland, in order to prevent by draining the flooding which now periodically occurs from Lough Neagh. The work is of a very extensive nature and will occupy five to six years, some 500 men being employed in dredging and auxiliary work. The total cost will be about £650,000. Two dredgers of special dimensions, designed to navigate the locks on the river, are to be built and orders for a tug and auxiliary plant have already been placed. The firm has also secured two other large contracts which, together with the one above-mentioned, amount in value to about one million pounds. The additional contracts include harbour and pier improvements at Douglas, in the Isle of Man, which will provide improved steamer accommodation, for larger vessels, and the dredging of the inner and outer harbours at Folkestone, which will facilitate the running and berthing of the Southern Railway Company's cross-Channel steamers.

Sir Ernest Rutherford.

IN succession to the late Sir William M'Cormick, Sir Ernest Rutherford has been appointed by the Lord President of the Council as Chairman of the Advisory Council of the Department of Scientific and Industrial Research. The appointment is to date from October 1st this year, and in the interval Professor V. H. Blackman will serve as Chairman. Sir Ernest Rutherford was born in New Zealand. After graduating at the University of his native country, he went to the Cavendish Laboratory at Cambridge, where he conducted research in physics. In succession, he became Professor of Physics at M'Gill University and at the University of Manchester, and in 1919 was appointed to his present position of Cavendish Professor of Experimental Physics and Director of the Cavendish Laboratory at Cambridge University. His studies have been chiefly devoted to radio-activity and the structure of matter. In 1908 he was awarded the Nobel Prize for Chemistry. In 1923 he was elected President of the British Association and since 1925 he has been President of the Royal Society.

New Airship Schemes.

ON what is apparently good authority, it is reported that the United States Government is making preparations to build, or to have built for it, a large metal-clad airship for service with the Army. The airship, it is said, is to be built at Scott Field, Illinois, and will cost about £900,000. The vessel will have a maximum diameter of 119ft. 6in., and a length of 547ft. Its gas capacity will be 3,758,300 cubic feet and its total weight about 67½ tons. The useful load will be, it is said, nearly 90 tons. Eight engines, developing a total of 4800 horse-power, will be provided to drive the vessel at 100 miles an hour. The military equipment will consist of one 37 mm. gun, ten machine guns, two aeroplanes, from 2 to 7 tons of bombs, 30,000 rounds of ammunition and a 1000-watt searchlight. This projected airship is presumably a development of the plans exemplified in the construction of the small metal-clad airship "Z M C 2," built by the Aircraft Development Corporation, of Detroit. That vessel was briefly described in our issue of January 3rd this year. It has a helium gas capacity of 200,000 cubic feet and carries a useful load of 3127 lb. It is composed entirely of metal, even the gas-containing skin being of aluminium alloy. It was taken over last September after successful trial flights by the United States Navy for experimental purposes. In the light of the data published concerning that ship, it is impossible to believe that the new vessel will develop a useful load of 90 tons, as stated. This figure will be found, we think, to represent the total weight of the airship and its load. If this suggested emendation of the published figures is correct, the useful load—the surplus lift available for carrying the weight of the military equipment, the crew, fuel, and stores—will be about 22½ tons. Rumours are on foot in this country that our Government is about to construct another airship, the "R 102," of 7,000,000 cubic feet capacity. A question on the subject was addressed this week in the House of Commons to the Under-Secretary of State for Air. Mr. Montague's reply was non-commital.

The New Cunard Liner.

ACCORDING to an official statement by the Cunard Steamship Company, Ltd., communications have been received from three shipbuilding firms, with regard to the proposed new liner for the North Atlantic express service. The firms are Swan, Hunter and Wigham Richardson, Ltd., of Wallsend-on-Tyne; Vickers-Armstrongs, Ltd., of Barrow-in-Furness; and High Walker, Newcastle-upon-Tyne, with John Brown and Co., Ltd., of Clydebank. The tenders which have been sent in are now being considered by the Cunard Company and its technical officials, but it is pointed out that in view of both the number and the importance of the factors involved, both within and without the company, some time must necessarily elapse before any further statement can be made. It is generally understood that the propelling machinery will be of the high-pressure geared turbine type, with water-tube boilers. Some correspondence has passed between John Brown and Co., Ltd., and the Clyde Navigation Trust with regard to the capacity of the river to accommodate a vessel of very large dimensions. The Trust has agreed that should a contract for the vessel in question be placed with the Clydebank yard, assurances as to the river will be given as requested without prejudice to the Trustees. On the other hand, hopes are expressed that the new liner may be built on the North-East Coast.

A New Railway Bridge at Folkestone.

ON Monday, May 12th, the new steel swing bridge which carries the Southern Railway track over the channel leading to the old harbour at Folkestone was safely placed in position, and the task of connecting up the railway lines was immediately begun, in order that the track might be ready for the train connecting with the 1.5 p.m. boat from Boulogne. The harbour line was closed at 4 p.m. on Friday afternoon, and the continental traffic diverted to Dover, and the work of removing and demolishing the old wooden bridge was at once begun. This work occupied a longer time than originally allowed for, as some hidden steelwork was not discovered until the work of cutting up had actually commenced. The old timber bridge was constructed in the period 1891–1893, and it weighed about 150 tons. Its place has been taken by a new steel swing bridge built by the Horseley Bridge and Engineering Company, Ltd., of Tipton, Staffordshire, which revolves on roller bearings. The new bridge weighs 275 tons, with a swinging weight of 260 tons, and it is supported on a 32ft. square pier at the centre. It spans a channel 132ft. wide, and when open two 30ft. wide openings into the old harbour are available for water-borne traffic. The new bridge was erected on a staging alongside the old bridge, and it was drawn into position by steel ropes attached to two winches, the actual operation occupying some two hours. Had no delay occurred, it had been anticipated that the whole work of replacement would have been completed in thirty-four hours, but actually the time taken was nearer forty-six hours. The work was done by the engineering staff of the Southern Railway Company and the contractors for the new bridge.

The Calcutta Electric Supply Corporation.

AT the thirty-third annual general meeting of the Calcutta Electric Supply Corporation, held in London on Monday, May 12th, the chairman of the company, the Right Hon. Lord Meston, stated that during the year 1929 the company sold 170,000,000 units, as compared with 148,000,000 units in 1928. The company had erected 17 miles of new overhead lines and 58 miles of underground cables. Important contracts had been concluded with new power consumers, and no fewer than 2848 additional houses were connected to the supply. The demand for current for domestic services, such as cooking, refrigerating, &c., was encouraging. The extra business had naturally increased the revenue, which, however, was discounted to some extent by an important concession to the consumer, for the tariff for high-tension power based on the kilowatts of maximum demand had been reduced by roughly 10 per cent. During the year there had been a very gratifying reduction in the working costs, and improvements in the plant had resulted in a smaller consumption of coal. The chief extension during the year was the completion of the new line to Serampore, which was being developed into a ring main by cables laid across the river bed at Cossipore and higher up near Jitaghar. The possibility of a largely increased load on the new extension had caused the directors to examine the Cossipore station, and it had been decided that it would have to be brought thoroughly up to date, and be relieved of part of the demand of the South Howrah area. Old generating sets and boilers would be replaced by larger and more modern units. Another matter that had to be considered was whether a new and third generating station should be built on the Howrah side of the river for serving that area, but it had been decided to tunnel under the river at the southern station and to run cables across to the right bank. It was hoped that the work would be completed by midsummer of 1931, and in the meantime the capacity of the southern station would be increased by the installation of a new 20,000-kilowatt set.

The Latest Ellerman Liner.

THE new Ellerman liner the "City of Barcelona," which has been built by Barclay, Curle and Co., Ltd., on the Clyde for the London service of the Ellerman Hall Line, is an interesting cargo ship on account of her special propelling machinery and the arrangements made for the lifting of heavy cargo. The new steamer has a length of 425ft., a beam of 58ft., a depth of 29ft. 9in., a measurement of 5600 tons, and a deadweight carrying capacity of 9500 tons. She is propelled by a four-cylinder, triple-expansion steam engine, which is fitted with valve gear of the Beardmore-Caprotti type. The cylinders have diameters of 23½in., 40½in., 50in. and 50in., with a common stroke of 48ft., and steam is supplied at a pressure of 265 lb. per square inch with 180 deg. of superheat. The exhaust steam from the main engine passes to an exhaust turbo-generator plant of Metropolitan-Vickers design, which supplies direct current to a 990 B.H.P. auxiliary propelling motor mounted in the thrust block recess at the other end of the engine-room. The deck auxiliaries include gear for lifting 108 tons, enabling cargoes of locomotives and heavy rolling stock to be conveniently handled. No particulars have been given us with regard to the trial results, which, it is understood, were very successful, but no doubt opportunity will be taken to compare the performance of this new type of propelling machinery with that of other modern steamers and motor vessels which are being operated by the Ellerman Lines. It may be recalled that in February last Mr. Wm. Hinchcliffe, the superintendent engineer of the Ellerman Lines, gave an interesting paper before the Liverpool Engineering Society, in which he contrasted the performance of the geared turbine steamer the "City of Roubaix" and the motor ship the "City of Lille."

Salvage Operations at Scapa Flow.

WORK is now well advanced at the Lyness Pier depot of Cox and Danks, Ltd., Scapa Flow, on the cutting up and dismantling of the ex-German light cruiser "Bremse," which was raised at the end of November. Operations have been delayed on account of the large amount of oil fuel in the compartments of the upturned double bottom of the ship, which has had to be burned out before the cutting up work could be proceeded with. The firm has also recently lifted with success four gun turrets, each weighing over 400 tons, which were cut off from the upturned hulls of the "Seydlitz" and "Kaiser" in order to allow the floating hulls to pass over the sill of the dry dock at Rosyth. Work is now steadily progressing on the preparations necessary for the refloating of the battle-cruiser "Hindenburg." The port side of the stern of the ship around the propellers has been totally encased in reinforced concrete in order to steady the hull when the lifting begins. In order to facilitate the pumping out of the hull a large air bell and air lock has been constructed and secured to the deck of the ship over the engine-room spaces. In this air bell the submersible pumps will be accommodated. Other groups of submersible pumps are placed forward, and work is proceeding on making water-tight the upper deck. Over one of the funnel base apertures a patch 40ft. by 20ft. with a height of 4ft. has been built up with heavy steel girders. If all goes well there is every reason to hope that the lifting operations will be begun about the middle of June. It will be recalled that the "Hindenburg" was partially floated in September, 1926, and a full account of the operation will be found in our issue of October 1st of that year.

The Automatic Stabilisation of Ships.

No. VII.*

It has been shown that the continuous precession of a gyroscope in one direction with constant velocity about the athwartship axis will provide a gyroscopic reaction, the vertical component of which about the longitudinal axis of the ship will just be sufficient in amount at any instant to balance the heeling moment of a sine form wave of period T, provided the gyroscope has a moment of inertia I and a speed of spinning $\dot{\phi}$, which are such that $K g/\dot{\phi} I = 2\pi/T$. In this expression, K has the value $\frac{1}{12} \frac{w b^2}{d} \cdot \frac{\pi H}{L}$, where w, b, and d are the displacement, equivalent beam and equivalent draught of the vessel, and H and L are the height and length of the waves. It has been shown that this elementary solution of the problem of gyroscopic stabilisation would require the speed $\dot{\phi}$ of the gyroscope to be varied to suit the magnitude of the waves encountered. It has been pointed out that there are almost insurmountable difficulties in devising a practical method of varying the speed $\dot{\phi}$ automatically to the required extent, and with sufficient absence of lag. It has been shown that apart from these difficulties the necessity which exists for keeping the centrifugal tension in the gyroscope wheel down to a safe value when the speed $\dot{\phi}$ is set to suit the maximum wave conditions imposes on us the employment of a wheel of uncomfortable size.

Let us now consider as an alternative solution to the continuous, constant speed precession of the gyroscope, its oscillation to and fro about the precessional axis through a range lying within ± 90 deg. about the initial or vertical position of the axle. Let us lay it down that the oscillation is to have an amplitude of $\pm\alpha$, where α is 90 deg. or less, and let us endeavour to discover whether complete stabilisation can be imparted under these circumstances, and, if so, what additions, if any, to the gyroscopic equipment are required in order to make it capable of imparting complete stabilisation to the ship.

In Fig. 23 there is represented a gyroscope oscillating on the athwartship or precessional axis through

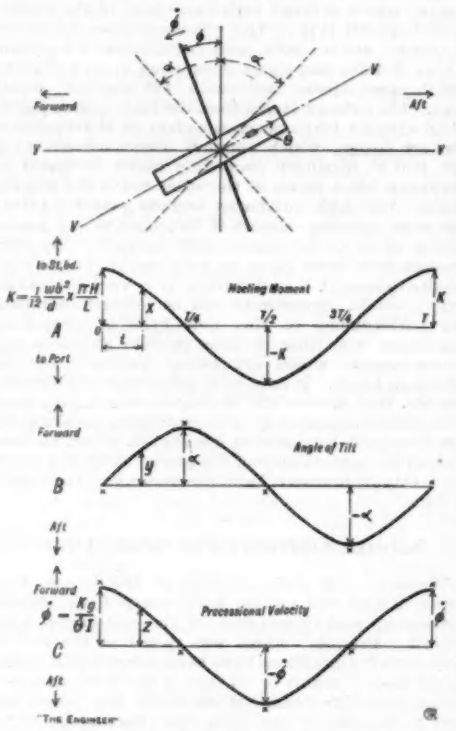

FIG. 23—OSCILLATING GYROSCOPE

an amplitude of $\pm\alpha$, and, below it, is shown the curve of heeling moments which the gyroscope, by virtue of its reaction, is required at each and every instant just to counteract. If the precessional velocity of the gyroscope at any instant is $\dot{\phi}$, its reaction about V V will be $\dot{o}\,\dot{\phi}\,I/g$, and the vertical component of this reaction available for counteracting the heeling moment applied about Y Y will be $\dot{o}\,\dot{\phi}\,I \cos\varphi/g$, where φ is the angle of tilt away from the vertical, reached by the gyroscope as a result of its precession. At the instant T/4 the heeling moment acting on the ship is zero. Therefore, at this instant the vertical component of the gyroscopic reaction should also be zero. The vertical component $\dot{o}\,\dot{\phi}\,I \cos\varphi/g$ can become zero in two ways, either by $\cos\varphi$ becoming zero or by the precessional velocity $\dot{\phi}$ becoming zero. The first alternative leads to the method of stabilisation indicated in the preceding article, for $\cos\varphi$ becomes zero when φ is 90 deg.; that is to say, the vertical component of the reaction will become zero at T/4 if the precessional velocity is such as to tilt the gyroscope through 90 deg. in T/4 seconds, which is equivalent to one complete revolution in T seconds. The second alternative applies to an oscillating gyroscope, and will clearly be fulfilled if the gyroscope at the instant T/4 is at the extreme limit of its amplitude α, for at that limit the velocity $\dot{\phi}$ of its oscillation will momentarily be zero.

Similarly, at the instant 3 T/4 the heeling moment is also zero. Therefore no reaction is required from the gyroscope and its precessional velocity should be zero. Hence, at 3 T/4 the gyroscope should again be at the limit $\pm\alpha$ of its amplitude.

At zero time the heeling moment has the maximum value K. The axle being vertical at this instant—that is to say, the diametral axis V V being coincident with the longitudinal axis Y Y of the ship—the precession $\dot{\phi}$ produced in the gyroscope will be given by $\dot{o}\,\dot{\phi}\,I/g = K$, and as a consequence the gyroscopic reaction developed about V V and acting in full about Y Y will be $-K$, and will just balance the heeling moment.

At the instant T the heeling moment is again K. Consequently, for complete stabilisation, the gyroscope at this instant should again be vertical, and should possess the same instantaneous precessional velocity $\dot{\phi} = K\,g/\dot{o}\,I$ which it had at zero time.

At the instant T/2 the heeling moment has the maximum value, but is reversed in direction. Hence, at this instant the gyroscope should again be vertical, and should possess the same value, $K\,g/\dot{o}\,I$, of the precessional velocity as it has at zero time and at time T, but should be moving in the opposite direction—aft instead of forward.

This analysis enables us at once to sketch in two curves B and C, representing respectively the angle of tilt and the precessional velocity required of the gyroscope at any instant in order that the vessel may be completely stabilised. The only definite points on these curves which our analysis enables us to fix are those marked with a cross, but the position of these points is sufficient to enable us to indicate the general trend of the curves.

It will be seen that the requirements indicated are that the gyroscope should oscillate to and fro on the precessional axis, reaching a maximum forward tilt at the instant T/4 and an equal maximum tilt aft at time 3 T/4, that it should be vertical at zero time, and at T/2 and T, and that it should make one complete oscillation in the period T of the waves.

It is scarcely possible without resort to a full mathematical analysis to determine the precise form of the curves B and C between the points marked with a cross. The solution of this problem is given in the appended mathematical note. It is less important for our present purpose to notice the precise result arrived at than to observe that an exact and complete solution of the problem is obtainable. In other words, at any instant t when the heeling moment is x—see Fig. 23—the conditions for complete stabilisation require that the gyroscope should have a definite angle of tilt y, and that it should be tilting with a definite precessional velocity z. The points marked with a cross on curves B and C being fixed, any number of curves might be drawn at random through them. The dimensions of the ship, the gyroscope, and the waves being given, analysis shows that there is one and only one curve B or C which will represent the tilt and precessional velocity required to make the vertical component of the gyroscopic reaction at each and every instant equal in amount and opposed in direction to the instantaneous value of the heeling moment.

We may take it, then, that an oscillating gyroscope is capable of imparting complete stability to a ship provided (*a*) the oscillation has a period identical with the period of the waves, (*b*) the gyroscope reaches the limits of its oscillation at the instants at which the heeling moment applied by the waves falls to zero, (*c*) the gyroscope reaches the middle of its oscillation at the instants when the heeling moment has its maximum value, and (*d*) the precessional or oscillation velocity at intermediate instants bears a particular relationship to the instantaneous angle of tilt of the gyroscope.

These being the requirements for complete stabilisation by means of an oscillating gyroscope, the question now arises as to how they are to be fulfilled.

Let us consider the first quarter period of the oscillation. At the outset the gyroscope axle is vertical and the heeling moment has the maximum value K. At the end of the quarter period the heeling moment is zero and the gyroscope axle should be tilted forward to the limiting angle α of its swing and should just be stationary and about to start returning to the vertical position. Initially, therefore, the diameter V V of the gyroscope is coincident with the axis Y Y about which the heeling moment K is acting. Consequently the gyroscope starts to precess forward with a velocity determined by the maximum value of the heeling moment and given by $\dot{\phi} = K\,g/\dot{o}\,I$. The gyroscopic reaction corresponding to their velocity will be $-K$, and as V V is coincident with Y Y it will just counteract the heeling moment and consequently the vessel for the instant will be fully stabilised. It should be noted that this instantaneous stabilisation will be given whatever be the size and speed of the gyroscope; that is to say, whatever be its "power" as represented by the product $\dot{o}\,I$. If this "power" is small the initial precessional velocity produced by the given heeling moment will be large, and if the power is great the precessional velocity will be small. In other words, the initial precessional velocity will be automatically adjusted to the power of the gyroscope in such a way that this product $\dot{\phi} \times \dot{o}\,I/g$ will be equal in magnitude to the heeling moment K instantaneously in action on the ship. Initially, then, the conditions for complete stabilisation require a gyroscope of no particularly defined size and speed. The only requirement to be fulfilled is that the gyroscope should be allowed to start precessing with the velocity natural to its "power" and the magnitude of the heeling moment in action.

As in the case of stabilisation by continuous precession dealt with in the previous article, the decreasing heeling moment about Y Y combines with the tilting of the diameter V V to apply to the disc a moment about V V which is less than the original or maximum moment K. The precessional velocity corresponding to this reduced moment is less than the initial precessional velocity and hence, friction being neglected, there is nothing in existence, so far as we have at present laid down the conditions under which the gyroscope is operating, either to increase or decrease the initial precessional velocity. That velocity, therefore, persists. In Fig. 24, diagram A represents the fact that the precessional velocity is

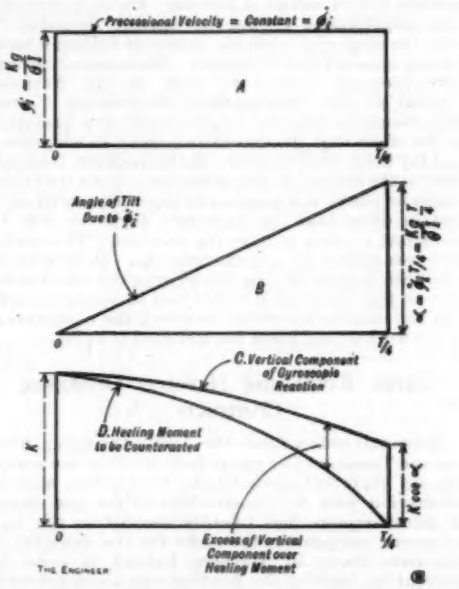
Precessional Velocity = Constant = $\dot{\phi}_i$
A
B
Angle of Tilt Due to $\dot{\phi}_i$
C. Vertical Component of Gyroscopic Reaction
D. Heeling Moment to be Counteracted
Excess of Vertical Component over Heeling Moment
THE ENGINEER

FIG. 24—REACTION OF OSCILLATING GYROSCOPE

constant at the initial value $K\,g/\dot{o}\,I$ during the first quarter period. Since the velocity is constant, the angle of tilt acquired by the gyroscope will increase progressively with the passage of time, as shown by diagram B. At any instant t it will be $K\,g\,t/\dot{o}\,I$, and in particular at the end of the quarter period it will be $K\,g\,T/4\,\dot{o}\,I$.

Knowing the precessional velocity and the angle of tilt of the gyroscope at any instant, we can immediately determine the corresponding vertical component of the gyroscopic reaction. This vertical component in general terms is $\dot{o}\,\dot{\phi}\,I \cos\varphi/g$, or, in this particular case, $\dot{o} \cdot \frac{K\,g}{\dot{o}\,I} \cdot I \cos \frac{K\,g}{\dot{o}\,I} t/g$, which reduces to $K \cos \frac{K\,g\,t}{\dot{o}\,I}$.

In particular the vertical component of the gyroscopic reaction at the end of the quarter period will be $K \cos \frac{K\,g\,T}{\dot{o}\,I\,4}$. We may therefore draw the curve C to represent the vertical component of the reaction. On the same diagram we can draw the curve D representing the heeling moment applied to the ship. This moment, as we know, is expressed by $K \cos \frac{2\pi t}{T}$ and is zero at the instant T/4. It is evident, therefore, that at any time t during the first quarter period the vertical component of the gyroscopic reaction is *greater* than the heeling moment which it is supposed just to balance.

The excess of the vertical reaction over the applied heeling moment is clearly given by

$$K \cos \frac{K\,g\,t}{\dot{o}\,I} - K \cos \frac{2\pi t}{T}$$

It will be noticed that this excess will be zero if $K\,g/\dot{o}\,I = 2\pi/T$, which takes us back again to the case already considered of complete stabilisation by continuous precession. The excess will, however, be real if $\cos K\,g\,t/\dot{o}\,I$ is greater than $\cos 2\pi t/T$; that is to say, if $K\,g/\dot{o}\,I$ is less than $2\pi/T$. Following up this criterion further, we see that the excess of the reaction over the heeling moment will be real if $K\,g\,T/\dot{o}\,I$ is less than 2π or if $K\,g\,T/4\,\dot{o}\,I$ is less than $\pi/2$. We have, however, already found that $K\,g\,T/4\,\dot{o}\,I$ is the value of the angle of tilt reached by the gyroscope at the end of the quarter period under the influence of the constant precessional velocity impressed on it at zero time. It is evident, therefore, that if the conditions are such that the gyroscope

* No. VI. appeared May 9th.

during the quarter period tilts to an angle short of 90 deg. the vertical reaction will show an excess over the heeling moment at every instant except just at the outset.

Complete stabilisation can only be given if the vertical reaction and the heeling moment are at each and every instant exactly equal. It is therefore clear that in the case we are examining complete stabilisation will not be given because of the fact that, except at the outset, the precessional velocity is too great. The excess of the vertical reaction over the heeling moment as shown by the curves C D increases from zero up to a maximum at the end of the quarter period. It follows, therefore, that in order to make this excess vanish and thereby to secure complete stabilisation at each and every instant during the quarter period we must progressively diminish or retard the precessional velocity impressed on the gyroscope by the initial or maximum heeling moment. The retardation must clearly be such as not only to reduce the precessional velocity to the requisite degree at any instant, but to wipe it out completely at the end of the quarter period.

We will leave for the time being the discussion of the nature and magnitude of the retardation required to give complete stabilisation by means of an oscillatory gyroscope and proceed to examine the corresponding control, if any, which has to be applied during the second quarter period.

At the beginning of this quarter period—that is to say, at time T/4—the heeling moment in action on the vessel is zero and is about to grow up in the reverse direction to that which it had during the first quarter period. The gyroscope has its maximum forward tilt, α, and is momentarily stationary as regards precession. A short time later the heeling moment has grown from zero to some small value, k, say, in the direction opposed to that of the heeling moment in action during the first quarter period. By virtue of the inclination α of the gyroscope, the component of this moment acting about the diametral axis V V of the disc will be less than k, but such as it is, it is in the direction required to precess the gyroscope backwards towards the vertical position. Still later the heeling moment becomes greater and the tilt of V V relatively to the axis Y Y, about which the heeling moment is acting, becomes less by virtue of the precession back towards the vertical which has now set in. The component moment acting about V V has, therefore, been increased by reason of both these factors, and as time goes on it will rise more and more rapidly with the increase in the heeling moment and the decrease in the tilt. The precessional velocity of the gyroscope has, therefore, a natural tendency to increase, and not a natural tendency to remain constant as it has during the first quarter period. The question, therefore, arises: Is this natural growth in the precessional velocity consequent upon the increasing moment acting about the diametral axis of the disc sufficient to develop at each and every

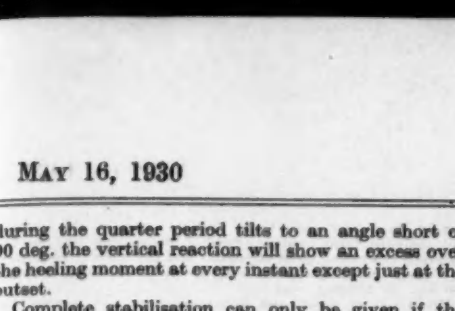

FIG. 25—GYROSCOPE RECOVERING VERTICAL POSITION

instant the gyroscopic reaction required to balance the heeling moment? The diagram—Fig. 25—provides the answer.

Let the heeling moment at any instant during the second quarter period be, say, X, and let the inclination of the gyroscope axle to the vertical at this instant be φ. Then the component of the heeling moment which the disc experiences about its diametral axis V V is X cos φ, and this component will produce a precessional velocity ϕ given by $\dot{\phi}\,\phi\,I/g = X\cos\varphi$. The gyroscopic reaction corresponding to this precessional velocity will be equal to the component of the heeling moment and be oppositely directed. This gyroscopic reaction X cos φ will be developed about V V. Its vertical component about Y Y will be X cos $\varphi \times \cos\varphi$, and, hence, will be in defect of the heeling moment by the amount $X - X\cos^2\varphi$, or $X\sin^2\varphi$. It is, therefore, clearly evident that the precession of the gyroscope, which is "natural" to the component of the heeling moment in action on it is insufficient to provide the reaction required to balance the heeling moment. The fact that the vertical component of the reaction is deficient clearly implies that we must act on the gyroscope to *increase* its natural precessional rate to the extent necessary to make the vertical component of the reaction at each and every instant equal to the heeling moment.

It will now be seen that the requirements for giving complete stabilisation to a ship by means of an oscillating gyroscope are that during the first quarter period the rate of natural precession should be retarded, and during the second quarter period accelerated. As a little reflection on the lines already employed will show the precession has similarly to be retarded during the third quarter period and accelerated during the fourth.

Mathematical Note.—If the heeling moment is expressed by H.M. = K cos $2\pi t/T$, then the condition for complete stabilisation is:

$$\frac{\dot{\phi}\,\phi\,I}{g}\cos\varphi = K\cos\frac{2\pi t}{T} \quad . \quad . \quad . \quad (1)$$

i.e.,

$$\cos\varphi\,d\varphi = n\cos Bt\,dt \quad . \quad . \quad . \quad (2)$$

where $n = K\,g/\dot{\phi}\,I$ and $B = 2\pi/T$.
Integrating (2) gives—

$$\sin\varphi = \frac{n}{B}\sin Bt + C \quad . \quad . \quad . \quad . \quad (3)$$

At $t = o$, φ by supposition is zero. Hence, $C = o$.

From (1) $$\cos\varphi\,\dot{\phi} = n\cos Bt \quad . \quad . \quad . \quad . \quad (4)$$

Differentiating we get:

$$\ddot{\phi}\cos\varphi - \dot{\phi}^2\sin\varphi = -n\,B\sin Bt \quad . \quad . \quad (5)$$

From (3), (4) and (5) it follows that—

$$\sin\varphi = \frac{n}{B}\sin Bt \quad . \quad . \quad . \quad . \quad (6)$$

$$\dot{\phi} = \frac{n\,B\cos Bt}{\sqrt{(B^2 - n^2\sin^2 Bt)}} \quad . \quad . \quad . \quad (7)$$

$$\ddot{\phi} = \frac{n\,B^2(n^2 - B^2)\sin Bt}{(B^2 - n^2\sin^2 Bt)^{3/2}} \quad . \quad . \quad . \quad (8)$$

(*a*) Let $n = B$ (*i.e.*, $Kg/\dot{\phi}\,I = 2\pi/T$). Then from (6) the maximum value of sin φ will be unity and will occur at the time given by $Bt = \pi/2$, *i.e.*, at $t = T/4$. If $n = B$, then from (7) $\dot{\phi} = B = 2\pi/T$ and from (8) $\ddot{\phi} = o$. This is the case dealt with in article VI. for complete stabilisation by continuous precession at constant speed.

(*b*) Let n be greater than B. Then equation (6) implies that at time T/4, sin φ will be greater than unity. Hence, if n is greater than B, complete stabilisation is impossible.

(*c*) Let n be less than B. Equation (6) shows that in this case the gyroscope will oscillate in the period T between the limits $\pm\alpha$ where $\sin\alpha = n/B$. Equation (7) shows that the oscillation will not be strictly simple harmonic to the extent that the denominator is not constant, but is a function of Bt. For n less than B, the denominator of equation (8) will always be positive. The numerator will be negative from $t = o$ to $t = T/2$, and positive from $t = T/2$ to $t = T$. The velocity $\dot{\phi}$ is from (7) positive from $t = o$ to $t = T/4$, and from $t = 3\,T/4$ to $t = T$, and is negative from $t = T/4$ to $t = 3\,T/4$. The moment, $\dot{\phi}I'/g$, required about the precessional axis is, therefore, such as to retard the precessional velocity in the first and third quarter periods and to assist it in the second and fourth.

(To be continued.)

Iron and Steel Institute.

No. II. (*Conclusion*).*

THE first paper taken on Thursday afternoon—May 1st—when the President again was in the chair, was "Single Sheet or Thin Pack Normalising, or Heat Treatment *versus* Box Annealing of Sheets," by R. Whitfield. The following summary is given by the author.

THE ANNEALING OF SHEETS.

The mass production of high-class sheets has received careful metallurgical examination, and practical means have been devised for achieving the improved results known to be obtainable from a consideration of the equilibrium diagram. Annealing in a box furnace offered only a partial solution, leaving the most important demands unsatisfied; practical difficulties prevented the attainment of the desired metallurgical results.

Modern artistic designs demand a high-quality sheet, having deep-drawing possibilities; the normalised or sorbitic sheet fulfils all the requirements.

The solution of the problem lies in single-sheet or thin-pack heat treatment, consisting of a careful preheating, soaking, and cooling—all controllable factors, unobtainable in a box furnace. This method enables the necessary temperature to be easily reached and controlled, and by reason of the quick cooling the fine structure and physical results are maintained uniformly across the sheet.

The modern normalising furnace is a practical machine, very adaptable for the production of sheets to any specification, especially where box annealing has failed. There are numerous advantages, apart from the superior metallurgical results, and there are undoubtedly possibilities for this process in other branches of the sheet trade.

Professor C. A. Edwards, who was asked by the President to open the discussion, said that as the paper was to be read in Swansea, he would prefer to reserve any comments until then.

Professor C. H. Desch expressed the view that the method of treating sheets described in the paper was so enormously superior to box annealing, that he would like to see it adopted very much more widely. It might also be applied with advantage to transformer sheet, which was not always as uniform as might be desired. He also suggested that electrical heating should be adopted instead of gas or petroleum. He knew that suggestion was usually laughed to scorn in any metallurgical gathering, because it had always been considered to be an expensive method, but, after what had been done in the non-ferrous industry with electrical heating in long continuous furnaces, he felt certain it could be adopted for treating sheets of the kind discussed in the paper. The control of the temperature with electrical heating was such that it might be possible, as had been done in the case of non-ferrous work, to eliminate pickling altogether. It was possible to send sheets through an electrically heated furnace so that they came out bright at the farther end without pickling, which latter was one of the most troublesome operations in the metallurgical industries.

Mr. A. T. Kathner said that the Edison Company, of Detroit, had experimented on the process described in the paper with electric heating, and it was hoped shortly to report favourably in that connection. So far, however, the work had only been done in the muffle furnace.

Mr. D. F. Campbell remarked that electric furnaces 130ft. in length, with bogies going in opposite directions, were being used at the present time with far greater economy than other types of furnace. The cost of the method had been greatly exaggerated.

Mr. Kathner said that it was not the question of cost that stood in the way, but the problem of obtaining the proper atmosphere, to prevent scaling.

Mr. J. Fallon said that the normalised sheet could be used much more effectively for deep stamping operations than the annealed sheet, and that had been shown to be the case particularly in the automobile industry. In stating that the fuel consumption with his process was comparable with that involved in box annealing, the author seemed to assume that the temperature in box annealing did not exceed 760 deg. Cent. It was the fact, however, that thousands and thousands of tons of sheet were box-annealed at temperatures exceeding 900 deg. Cent. in Great Britain every week. In fact, the temperature of 760 deg. Cent. was more nearly that used for removing cold work. The author had also been grossly misinformed with regard to the cost of box annealing. A figure for box depreciation of 2s. 6d. per ton was mentioned, but there were box annealing plants in this country dealing with 4000 tons per week in which the cost of box depreciation did not exceed 1s. 4d. per ton with a dish depreciation of 3d. per ton, making a total of 1s. 7d. per ton, whilst the fuel consumption was 1¼ cwt. per ton. He had heard of no disc roller furnace which would operate with less than 3 cwt. per ton; if there was, he would be pleased to hear of it. Without in any way wishing to belittle the value of the process described in the paper, he pointed out that the idea of normalising was by no means new, and, in fact, it was done accidentally in most continuous strip mills. The strip was delivered at speeds running up to 30 miles an hour, and at a temperature of 900 deg. Cent. was annealed naturally and was in the normalised condition. As to the use of electricity, he doubted whether it would be economical in present circumstances. Two 180ft. furnaces with an output of 1300 tons per week each would cost £200 per week in electricity at 100 per cent. efficiency and at ½d. per unit the cost would be something like £65,000 per annum.

The author, in the course of his reply to the discussion, said that whilst agreeing with what Mr. Fallon had said as to the cost of box depreciation, the fact was that the cost was proportional to the fuel consumption per ton, roughly speaking. If the fuel consumption was 2½ cwt. per ton the box depreciation was 2s. 6d. per ton, and if the fuel consumption was 3½ cwt. then the cost would be 3s. 6d., and he knew of works where the fuel consumption was considerably more than 2½ cwt. or even 3 cwt. per ton. If we were to keep our markets, we could not afford that, and it would be justifiable to pay money in order to effect economies. He also knew that a temperature of 900 deg. in box annealing had been used, but it was not general, and the majority of box annealing furnaces ran at 750 deg. to 800 deg. It did not necessarily follow that by the adoption of electricity we should get bright annealed goods; it was necessary to have the right atmosphere, and that was a difficulty with electricity at the present time. For bright annealing it was necessary to have a special furnace, a special container and a special gas.

The following paper was then presented:—"Tin and Sheet Mill Rolls: Their Treatment, Performance and Premature Failure in Service," by E. R. Mort.

TIN AND SHEET MILL ROLLS.

The sheet plant to which the data in this paper relate comprises sixteen hot mills of the single-stand type—that is, there are no roughing stands, all bars being broken down and finished off on one pair of rolls. Gauges of sheets rolled range from 6 B.G. to 31 B.G. (0·198in. to 0·011in.) inclusive, in widths up to 50in. and lengths up to 144in. On twelve mills the roll body diameter is 32in. and 28in. on the remaining four mills. Body lengths range from 38in. to 56in. in conformity with the widths of sheets in demand. For the period covered by most of the data—two years—plant operations approached 100 per cent. of capacity.

Given a roll of right analysis and good physical properties, the question of the "life" or performance arises. British roll manufacturers claim that twelve weeks—192 eight-hour turns—constitute a full life; the life, therefore, is based on time, tonnage produced not being taken into consideration. While users do not accept this basis as being at all equitable, it must be admitted that the subject bristles with difficulties, and it is not easy to suggest a basis acceptable to both makers and users. For sheet mill rolls an equitable basis suggested would be one that covers both weight of roll and weight of sheets—converted to a 24-gauge basis—produced during the "life," that is, a "ton of sheets per ton of roll" basis. At tin-plate mills, where production is calculated in boxes of 31,360 square inch, the basis would be "base boxes per ton of roll." From experience, a fair range for heavy sheet mill rolls would be 175 to 200 tons of sheets per ton of roll, and for tin mill rolls 4500 to 5000 boxes per ton of

* No. I. appeared May 9th.

roll. The tin mill suggestion covers mills of the double-stand type. The question of the premature failure of rolls in service is discussed in detail under a number of headings.

Mr. G. H. Strick suggested that a rather higher percentage of silicon is necessary than the 0·75 per cent. mentioned by the author, and his experience had been that 1 to 1·25 per cent. is the figure which used to be called for by the roll makers. As to the depth of chill, he preferred ¾in. to the ½in. mentioned in the paper. The water cooling of rolls was not altogether without danger, and a case had happened within the last twelve months in a well-conducted works where there had been a very large number of breakages, which for a while could not be accounted for. Then they stopped the water cooling and the breakages stopped. Probably the water cooling was not uniform; there might have been too much cooling on one side as compared with the other, and it was not always possible to get the men to do everything according to orders. Experience seemed to show that unless the cooling was done very carefully there was a risk of breakage. There were also risks from stresses owing to the fact that, in winter time, the top of the rolls might be exposed to draught coming in from windows, whilst the lower portion was protected, thus setting up unequal stresses.

Mr. Archibald Allison suggested that the time had come when roll makers should keep a record of the rolls they supplied, and the author had set a lead in giving a record of service. The suggested annealing of rolls was a debatable point, and there was a practical consideration in that connection which was not without interest. Usually rolls were cast on a Tuesday and removed from the mould on the following Thursday, but if they were cast on Friday they were not removed from the mould until the following Monday. They had an extra twenty-four hours' cooling in the mould, and those rolls, according to records he had seen gave better results than those cast on Tuesday. That was apparently due to a kind of mass annealing during that extra time. As regarded the suggestion that rolls with a high carbon content had a very short life, he thought that it would be found that the grinder would say that he could not put such a high polish on rolls with a low carbon content. At the same time, he agreed that a high carbon content adversely affected the life of the roll, but he did not think the manganese or silicon affected it. He agreed with Mr. Strick that ¾in. chill was better than ½in., and asked how the author measured his chill depth, because he had not found two people measure it in the same way. It was highly probable that mill conditions accounted to a large extent for roll failure, because it was not unknown for two rollers made of the same material from the same ladle to give different results, and therefore information such as was given in the paper of the operation of rolls was exceedingly valuable.

Mr. D. F. Campbell said that there were more than 200 instances in the United States in which rolls were heated electrically by the induction method, which consisted of placing the primary coil round the rolls. These heaters were put on at six o'clock on Sunday night and were taken off at six o'clock on Monday morning, and annealing could commence at once. The current was cheaper at that time than at any time during the week. Such an induction type of heater cost £150 and there might be another £150 or £200 in respect of switchgear, transformer, &c. Figures which had been collected for a number of rolls over a period of eight months indicated that there were fewer breakages with rolls so heated; indeed, the savings made in that respect were sufficient to pay the cost of the installation. The heater could be attached in a few minutes and the results obtained were quite different from those obtained when using the American method of a resistance heater which heated the outside surface only.

Mr. J. Shaw, referring to the emphasis laid in the paper on the necessity for correct alignment and levels, said that Mr. Bennett, of the Tata Iron Company, had stated that, by attention to those two points, together with efficient lubrication, he had halved the breakage of rolls in certain mills. Whether or not we agreed with the statement in the paper that 90 per cent. of all sheet and tin-plate rolls were broken owing to conditions arising from warming them up too rapidly at some time or other during their life, the utmost care was necessary in that direction, and the author's fuel oil method was a step in the right direction. How far it was fool-proof, however, was not stated, and unless some definite method of control were fixed there was liability to abuse of that method. Again, if care was needed in warming up, almost equal care was necessary at the end of the week's work when cooling down took place. Mills were shut down while the rolls were nearly at full temperature and the top roll was exposed to the cold draughts probably from the open-ended shed. Again, when the rolls were taken out for re-dressing they were probably dropped on to a cold plate. Treatment of that kind tended to shorten the life of the roll. As regarded roll performance, he asked whether the author would take full responsibility for the life of any given roll providing the analysis was within practical limits of the one stated early in the paper and the chill was approximately ¾in. deep. If so, then the question of responsibility would be settled at the outset. He did not agree with the author that the analysis should be such as to ensure maximum strength, because recent investigations had shown that metal of that character was too unyielding when the different expansions came on and caused slight fracture in the centre, which eventually led to complete rupture. Further, it was not always wise to judge of the character of a roll by the analysis without knowing the full history of its manufacture. Several British and continental firms were coating their chill with a thin refractory material, but to obtain the same chill depth under those conditions required a lower silicon, if other elements were kept constant. The same also applied to a recent patent, according to which the cooling rate of the cast roll was retarded over the critical periods.

Mr. H. S. Carnegie (English Electric Company, Ltd.) said that whilst heating by gas or oil was cheaper than by electricity as regarded first cost, it was not capital cost alone that should be considered. What must be considered was a combination of capital cost and results. The induction method mentioned by Mr. Campbell he regarded as approaching the ideal system of heating much closer than any other type. The resistance heater suffered from many disadvantages in comparison, the chief being that it applied a high temperature on the surface of the roll and developed cracks, but the cost of running an induction electric heater was high. He desired to ask the author, did preheating justify its expense by the results obtained?

The President asked the author to reply in writing.

The final paper taken at the afternoon session was one on "The Metallography of Some Ancient Egyptian Implements," by Sir H. C. H. Carpenter and Dr. J. M. Robertson.

SOME ANCIENT EGYPTIAN IMPLEMENTS.

In April, 1929, one of the authors was asked by Mr. Reginald Smith, Keeper of British and Mediæval Antiquities at the British Museum, to examine a spear head of the early Iron Age, one of a group preserved in the British, London, and Aylesbury Museums. In shape it resembled the cast bronze spear heads of the late Bronze Age, and on this account differences of opinion existed as to whether this group had been forged or cast. A microscopic examination carried out at the British Museum showed that the spear head had been forged from ordinary direct iron. The results of the examination, together with a sketch of the crystal structure, were described in a letter to *Nature*. Immediately upon the publication of this letter, Sir Flinders Petrie wrote offering the loan of metal specimens contained in his Egyptian collection at University College, London, for metallographic examination. With his assistance, nine representative specimens were selected, and have been duly examined, not only from the point of view of their inner crystal structure, but of what may be called their "micro-hardness." The present paper gives an account of the results of this examination.

So far as the authors know, the facts disclosed in the present work constitute the first definite evidence that carburising, quenching, and the advantages of heat treatment generally were understood many centuries before the Christian era. It has often been suggested that such operations were performed, but there has been no evidence. Hitherto, the earliest direct evidence of hardening is that provided by Hanemann, whose specimen belonged to some time near the beginning of the Christian era. The present investigation carried this direct evidence many centuries further back; this in itself is interesting, but the results of the present study reveal a good deal more than that. Due consideration of the nine specimens described shows that the early Egyptian metallurgists were highly skilled in all aspects of heat treatment except tempering.

In the opinion of the authors, it seems probable that the Iron Age did not properly begin in Egypt until the technique of carburising and heat treatment generally had been discovered and well developed, or, to put the matter somewhat differently, it was not until iron had been converted into steels that the Egyptians obtained a range of alloys which were superior in their properties to bronze and capable of more varied applications. In countries, however, where bronze was practically unknown, where notable skill in its manipulation had not been attained, or where the requisite ores were not readily available, the investigation of iron would follow more closely on the first discovery of this metal, and its development and use would be more rapid.

The paper was discussed by Colonel N. T. Belaiew, Dr. W. Rosenhain, F.R.S., and the President.

Colonel N. T. Belaiew made some interesting archæological comments, and Dr. Rosenhain pointed out how the investigation of Japanese swords furnished an example showing that a hardened and tempered structure could retain its hardness for many thousands of years, a point which he suggested might be impressed upon those people who held the view that heat-treated materials might not be sufficiently stable for a structure which would probably be obsolete in a good deal less than 100 years. Certain engineers definitely hesistated to use heat-treated steels for the reason he had mentioned, but in view of the paper it would seem that their fears were entirely groundless.

The President suggested that the authors gave the ancient workers credit for a little too much knowledge and did not allow sufficiently for chance in the results which they obtained. Personally, he was not inclined to attach too much importance to the metallurgical knowledge of the ancients.

The reply to the discussion was promised in writing, and the meeting adjourned until the following day.

The first paper presented on the Friday morning was one on "Some Alloys for Use at High Temperatures," by Messrs. Rosenhain, Jenkins, Tapsell, Austin, and Rees, Part I. of which was presented by Dr. Rosenhain and Part II. by Mr. Jenkins.

ALLOYS FOR HIGH TEMPERATURES.

The investigations described in this paper were carried out at the National Physical Laboratory (Engineering and Metallurgy Departments), under the auspices of the Committee on the Behaviour of Materials at High Temperatures of the Department of Scientific and Industrial Research for the Engineering Co-Ordinating Research Board, and later for the Metallurgy Research Board of the D.S.I.R. They were undertaken for the purposes of studying some of those alloy systems which appeared likely to yield materials having great strength at high temperatures. It was desired to find, if possible, alloys which should satisfy more fully than those already available the present and probable future requirements of engineering practice for materials possessing great strength—and particularly resistance to "creep" under prolonged loading—at temperatures between 650 deg. and 800 deg. Cent.

The alloys of nickel and chromium were first selected for study, and the present paper describes the results of this investigation, which was conducted concurrently with an extensive study—on behalf of the Committee—of the high-temperature properties of existing materials which has furnished valuable data for comparison.

The paper chiefly relates to the preparation and mechanical properties of alloys of nickel containing 20 to 40 per cent. of chromium, but certain sections of the work cover a larger field and include alloys containing 0 to 60 per cent. of chromium. The results of the mechanical tests on alloys containing 50 to 60 per cent. of chromium did not justify further detailed examination of this region. The results of the present investigation suggest that alloys containing 10 per cent. of chromium should be further investigated; at the outset they were not regarded as particularly important, and were not included in the programme. The development of complex alloys of especially high strength must also be regarded as still in the preliminary stage, although considerable advance has been made.

The present research indicates that considerable further improvement can be obtained by extending the range of chromium content, although the proportion is not likely to exceed 40 per cent. A large number of alloys containing as much as 60 per cent. of chromium with various proportions of nickel have been examined.

The present exploratory study of the nickel-chromium and nickel-chromium-iron alloys, which is more fully described in Part II. of the paper, shows the effect of composition on the properties of the materials. The investigation of the more complex alloys derived from the simpler binary and ternary alloys has led to the production of materials which are markedly stronger at high temperatures than any previously described. The present paper indicates that very considerable improvement in this type of material is possible, and the results have an important bearing on the probable direction of future developments.

Dr. W. H. Hatfield, who opened the discussion, said he accepted the paper as an extremely valuable contribution, and added that, with limited time and resources at their disposal, the investigators had tackled an extremely broad subject. Even in a binary system, having just two elements, a very large number of alloys must be made in order to cover the range completely, but when one came to ternary and quaternary systems, and series of alloys containing five, six, or seven elements, the problem became vast indeed, and it was really useful to point out that the subject was beyond mathematical treatment. Intuition was necessary in guiding the investigator in the choice of the compositions for full exploration, and a survey of the paper showed that the authors had been successful and wise in the particular compositions they had chosen for the purpose of an empirical survey of the system. They had indeed given a huge mass of constructive data which those engaged in the works would know how to use properly. At the same time, they had not been successful in producing heat-resisting alloys which were superior to those already produced by the several works research organisations which had been working on the subject, in that range of composition to which the economics of the situation had compelled manufacturers to confine themselves. The alloy which was postulated in the paper as representing an improvement on the industrial heat-resisting steels on the market contained 30 per cent. of nickel, 30 per cent. of chromium, and 4 per cent. of tungsten. The authors were driving us on to an alloy less than a third of whose weight consisted of iron. Steel makers would agree that if one departed from the steels and used alloys containing not more than 30 per cent. of iron, then one did produce materials which represented an improvement on the heat-resisting steels; but at what cost? Dr. Rosenhain and his collaborators had quite rightly ignored the economic question, but investigators within the industry must always bear that in mind, and the gratifying part of the paper, so far as he (Dr. Hatfield) was concerned, was that the data in it really gave the hall mark of the National Physical Laboratory to the work which had been done in the industrial laboratories.

Discussing some of the details of the paper, Dr. Hatfield pointed out that the main method of valuing the alloys was that of determining the time occupied to produce rupture under stresses somewhat above the limiting creep stress. That information, however, though a little more valuable than the results of the ordinary tensile tests, was not very much more valuable. The point to be borne in mind in connection with heat-resisting steels was that one was asked to provide a metal which would withstand high temperatures—probably in excess of red heat—and would also withstand stress and resist deformation. One wanted to know, therefore—and the resources and time at the authors' disposal did not permit them to give it—the stress which an alloy would withstand indefinitely without deformation. That was the only figure, from the mechanical strength point of view, which was of interest to engineers. His company hoped to be able to publish very soon the results of its own work in that connection.

He suggested that the National Physical Laboratory might study more deeply the constitutions of these complex alloys—a matter upon which metallurgists were almost completely ignorant. Again, he asked if tests on the capacity of the various alloys to resist scaling and oxidation were being carried out at the laboratory, because with variations in composition, quite considerable differences in the ability of the materials to resist scaling were to be observed.

Mr. J. F. Kayser, although acknowledging that the information given in the paper was of the greatest possible interest to steel makers, suggested that it was at least ten years late. Undoubtedly the tests had

been carried out with very great care, but, so far as he could see, one fundamental error had been made in that only one cast of each particular analysis was made. The trouble in connection with such alloys was that of obtaining uniformity, and in making trials one frequently obtained a freak cast which gave remarkably good results, but one could not repeat those results. Each cast should be repeated three times, if possible, under different melting conditions, and using raw materials of a different nature.

Mr. E. H. Saniter, after complimenting the authors on their courage in tackling such an enormous subject, referred to the trouble of "bridging" which had been experienced, owing to the top crust being difficult to melt, and suggested that if some neutral slag, such as silicate of alumina, had been added to the material it would probably have floated to the top and prevented the bridging; furthermore, it would have had the effect of removing some of the non-metallic impurities which existed in the raw materials used and were also produced by reactions with the crucible lining. It was a surprise to him that it was necessary to deal with deoxidation in the circumstances of manufacture in vacuo, and it was also surprising that the authors had selected such a material as magnesium for the purpose. It was somewhat volatile, though certainly a good deoxidiser when temperatures were suitable. The authors had deoxidised with a 50/50 nickel-magnesium alloy, and that might have improved matters to some extent, but it seemed to him that magnesium could not be a very satisfactory for deoxidising. The authors had tried aluminium for deoxidising, and had obtained satisfactory results. He could not help thinking that aluminium, used with care, was probably a better deoxidiser for the material the authors were manufacturing than was magnesium.

Mr. E. W. Colbeck said that probably the paper's greatest value lay in the fact that it represented a rapid survey of an extremely large field. With regard to the size of the castings dealt with, he pointed out that the wall thickness was not greater than about 2in., and suggested that a few tests on the effect of mass at elevated temperature would be very interesting. He would also like to know what would happen to the 0·5 per cent. and 1 per cent. carbon alloy castings under prolonged tests such as 50, 100 and 200 days. Would there be an aggregation or migration of carbide particles to the grain boundaries, or changes of that nature?

After Mr. Jenkins had replied on several of the points raised in the discussion, Dr. Rosenhain expressed his gratification with the reception accorded the paper, and said that if a paper from the National Physical Laboratory did not arouse some criticism he would feel that it offered nothing new. The conditions under which the authors had worked were, perhaps, peculiar. It seemed to be thought by Dr. Hatfield that the authors had not done enough exploring, and he agreed; but he pointed out that even the resources at their disposal were not unlimited; their resources were probably quite small as compared with those which large steel companies could devote to problems of that kind, and, consequently, they had not pursued the matter beyond a certain point. They could not make large castings; to do that it would have been necessary to have built large furnaces in order to melt the metal in the necessary quantities. As to the suggestion that they should have used commercial methods of making the materials, he considered that would have been altogether wrong, because commercial methods were meant for making large quantities, and such methods applied to small quantities were generally unsatisfactory in their results. Whether it would be possible to melt the materials otherwise than in vacuo, except on a large scale, he was not prepared to say, but the authors could claim as something of an achievement that on a very minute scale they had succeeded in making reasonably good specimens with those very difficult materials. With regard to Dr. Hatfield's remarks concerning the tests in which the time occupied in producing rupture under a load slightly higher than the creep stress was determined, he pointed out that the mechanism of failure in those tests was quite different from the mechanism of failure in a short-time tensile test.

The authors had not made quantitative measurements of scaling, but they had watched the alloys very carefully. In the case of alloy No. 183, and all the alloys which came out well, their resistance to oxidation was extremely good; the less iron in them, of course, the better they were from that point of view; but, again, the other properties must be considered.

Discussing the economic side of the problem, he said that the results given in the paper might have been late in some ways. What people had been doing with proprietary articles he was not in a position to know, but when the authors' work was started the materials were asked for for a specific service purpose. The best material at that time had been submitted to a long-period creep test, and it stood 2 tons per square inch at 800 deg. Cent., but the stress required to break it in 50 days was very much lower than that required to break the best of the authors' alloys at 50 days.

A paper by Mr. J. A. Jones on "Chromium-copper Structural Steels" was then taken. The author's conclusions run as follow:—

CHROMIUM-COPPER STRUCTURAL STEELS.

Investigation of steels containing about 0·3 per cent. of carbon, 0·5 to 1 per cent. of manganese, up to 1·5 per cent. of chromium, and up to 1·2 per cent. of copper, leads to the following conclusions:—

(1) Steels containing chromium in addition to manganese do not offer any advantage for structural purposes over the usual type of steel containing high manganese only.

(2) The addition of from 0·5 to 1·2 per cent. of copper to steels containing up to 1 per cent. of chromium leads to a marked improvement in the properties.

(3) In addition to their improved resistance to atmospheric corrosion, steels containing about 1 per cent. of copper offer the further advantage that they are less sensitive to variations in the rate of cooling after normalising.

(4) Within the range of composition investigated, the best properties were obtained in a steel containing 0·3 per cent. of carbon, 0·5 per cent. of manganese, 0·9 per cent. of chromium, and 1·2 per cent. of copper. The mechanical properties of this steel compare favourably with those of the best manganese-silicon structural steels, and are better than those obtainable in structural steels containing high manganese only.

There was very little discussion of this paper, and the next by Messrs. Haughton and Becker on "The Constitution of the Alloys of Iron with Silicon," was then presented.

ALLOYS OF IRON WITH SILICON.

The present is the ninth paper embodying results of the Research on the Alloys of Iron which is in progress at the National Physical Laboratory under the auspices of the Alloys of Iron Research Committee. The work is being carried out under the direction of Dr. W. Rosenhain, F.R.S., who set out the aims and purpose of the work in the first paper of the series.

The constitution of the alloys of iron with silicon has been determined, using materials of a much greater purity than have been available before, and taking every precaution to avoid contamination of the alloys. Very considerable differences exist between the present results and those of the previous observers, differences which are doubtless due in part to the purity of the materials used. The existence of phases which appear to correspond with the compounds FeSi and Fe_2Si_3 has been confirmed, and in addition a phase which is probably the compound Fe_2Si_5 has been shown to exist.

Professor J. H. Andrew, after complimenting the authors upon the excellent work described in the paper, referred to the small area known as the α-γ loop in the iron-silicon diagram, this loop representing the change from the α to the γ iron between 1300 deg. and 1400 deg. He suggested that if the authors would devote some of their time specially to working out that area, it would be extremely valuable, because that was really the most important part of the diagram. The transformer irons depended on the fact that the iron was in the α state right from the temperature of freezing to the ordinary temperature, and since the authors were working with exceedingly pure materials, one would like them to make an accurate determination of that value. He suggested that they might take about 10 alloys, each varying by about 0·2 per cent., and find—by extrapolation, of course—exactly where the loop came.

Dr. Haughton, in reply, pointed out that, as stated in the paper, the α-γ transformation zone had been so carefully worked out by other investigators that the authors had considered it necessary to examine only four alloys, and their results agreed very closely with those of previous workers. However, it might be worth while investigating the point most closely.

Three other papers were taken. They were "Carburising and Graphitising Reactions between Iron-carbon Alloys, Carbon Monoxide and Carbon Dioxide," by Dr. Becker, on which Dr. A. Bramley spoke; "The Effect of Melting Conditions on the Microstructure and Mechanical Strength of Grey Cast Irons containing Various Amounts of Carbon and Silicon," by Messrs. Norbury and Morgan; "The Properties of Some Steels Containing Chromium," by Messrs. Page and Partridge.

There was no discussion on these last two papers.

The President, in the course of his response to a vote of thanks which was accorded him, commented upon the high standard of the papers, and said that perhaps the best evidence of that was that there had been little discussion of a number of them. When papers which contained a lot of new facts, and which required a great deal of thought, were presented, there could not be much discussion, because there were very few people competent to discuss them.

ANNUAL DINNER.

THE annual dinner of the Institute was held in the Connaught Rooms on Thursday evening, May 1st, with the President, Professor Henry Louis, in the chair. The toast of "The Institute" was proposed by Sir Charles P. Trevelyan, the President of the Board of Education. In the course of his reply to the toast, Professor Louis made reference to the very heavy taxation to which British industry was subjected. In view of this taxation the iron and steel industry found, he said, very serious difficulties in providing against obsolescence and making those alterations in plant and processes which obsolescence made essential if progress was to be maintained. He did not consider that the iron and steel and allied industries were receiving proper consideration from those responsible for the country's finance.

The toast of "The Guests" was given by Sir Hugh Bell in a happy speech. Sir Hugh said that although there were those who considered that the iron and steel trades in this country were coming to an end, he was of opinion that such a view was not a true one, and that there was no need to fear the future. The toast was replied to by the French Ambassador, Monsieur Aimé Joseph de Fleuriau. The toast of "The Iron and Steel Industries" was proposed by Monsieur Eugene Schneider, a past-president of the Institute, who referred to the progress made in the production of iron and steel. If such progress was to be measured by production, it was significant, he said, that in 1929 the total world output had reached 119,000,000 tons, an increase of 60 per cent. on the figure for 1913. There were evident signs of an economic revival, the importance of which could not be denied, and he thought that it was not unreasonable to assume that the world's potential demand was far above the production figures for 1929. In replying to this toast, Sir Peter W. Rylands, President of the National Federation of Iron and Steel Manufacturers, said that there appeared to be no limit to possible future developments in the use of iron and steel. From past experience it was suggested that within the next 20 years the world's consumption of steel might reach a figure of stupendous magnitude. He felt that the feeling of British steel makers was, with regard to the future, one of optimism. There was a large attendance of members and guests, and the evening was a most successful one in every way.

The Punjab and Sind Floods of 1928 and 1929.

WHATEVER may be the decision as regards the procedure advocated in THE ENGINEER of September 13th last—as to the collection and collation of all significant data relating to the recent floods in the Punjab—it is unlikely that any considerable amount of information regarding the maximum discharges of the rivers and the effects of the floods will be available for some time to come. It seems, therefore, expedient to record, now, some details which have recently come to hand. The information relates to an area so vast—see Fig. 1—and to engineering works of such great importance that it is worth while to present it in company with matter explanatory of the conditions of the area and suggestive of the nature of the forces encountered and the problems which had to be solved by Punjab irrigation engineers. A hitherto unpublished note on the Punjab floods of 1928, with sketch maps—Figs. 2 and 3—provides such a background for the items of information relating to the recent floods on the Five Rivers, and furnishes besides some interesting details of the effects upon irrigation works of the 1928 floods. It is accordingly incorporated as follows:—

THE PUNJAB FLOODS OF SEPTEMBER, 1928.

In the night of September 1st and 2nd, 1928, 11in. of rain fell over the Himalayas between the valley of the Sutlej and the Indus, causing record floods on the Chenab, Jhelum and Indus rivers. At 8 p.m. on September 1st the Chenab—see Fig. 2—was discharging only at the rate of 50,000 cusecs at Merala, where are the headworks of the Upper Chenab Canal; but by midnight the flow was 750,000 cusecs. These works were designed for 600,000 cusecs. There was a severe flood on the Jhelum also, and the Lower Jhelum Canal was breached by the river breaking into it where it hugs the high bank for the purpose of "gaining gradient"—avoiding any lowering of level other than that necessary to maintain a suitable flow—in order to enter the Bangar or upland of the valley. The flood found an entrance to it at Ala—Fig 2—where the canal is in embankment over a drainage that crosses it a few miles below the headworks—see Fig. 3—wrecking two bridges. The canal was, however, functioning as usual within a few weeks.

PANJNAD WEIR.

At Panjnad, below the junction of the Chenab and the Sutlej, the fourth, or last, weir of the Sutlej Valley project was under construction. Fortunately for the safety of these works, the Jhelum has a steeper fall than the Chenab, and its flood reached Panjnad three hours before the arrival of the flood from the Chenab, by which time the crest of the Jhelum flood had passed. It is probable that it exceeded 700,000 cusecs, which was, some fourteen years ago, the estimated maximum at Mangla. Had both floods arrived at the same time, or more nearly together, considerable damage might have been done to the works and canals. The Jhelum and Chenab Khadir—lowland or valley bottom—suffered some loss of life as well as severe loss of cattle, grain and houses.

TRAINING WORKS ON THE CHENAB.

The headworks at Mangla—Figs. 2 and 3—and those at Rasul, both on the Jhelum, suffered no unsual damage—the word "unusual" is significant, however—nor did those at Merala on the Chenab; but considerable damage was done to training works along the right bank of the river, between the place where the Upper Jhelum Canal enters it and the Khanki Weir. Before the construction of the Upper Jhelum works, in 1914, a formidable hill torrent called the Bhimbar, which drains the lower hills in the Gujrat district, joined the Chenab below the Khanki headworks—see Fig. 3. This torrent is taken into the Upper Jhelum Canal and so diverted into the Chenab some 6 miles above the Khanki Weir. The

training works referred to above, designed to prevent the Bhimbar from breaking back into its old course, held under the severe test of the flood and were repaired and strengthened in the light of the information gained. The damage might have been much greater had not the flood abated rapidly, so that the damaged groynes were not exposed to a long-sustained attack from an abnormally high river. The old training works proper to the Khanki Weir, built in 1892, were not severely damaged, a record flood which occurred in that year having suggested their

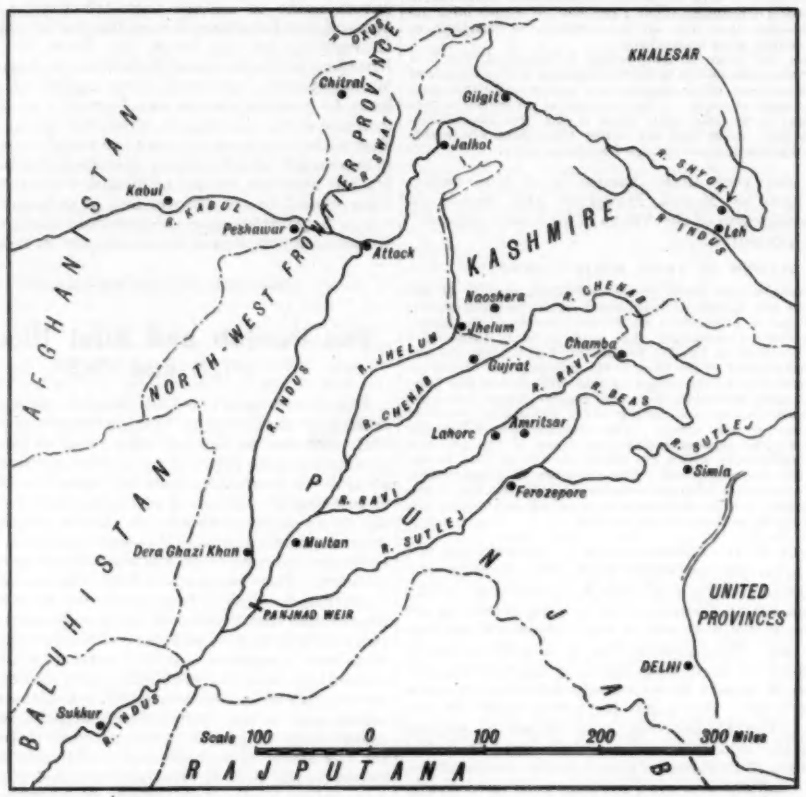

FIG. 1

situated where the river leaves the lower Pabbi Hills on the Gujrat side and the Salt Range on the Jhelum side, a site involving little training work.

At Mangla—Fig. 2—the Jhelum leaves its narrow and deep channel in the rocky Himalayas, where its range of surface levels is 40ft., to spread out as a wide, shallow river on the soft rocks of the Pabbis and Salt Range. This transition is marked by a natural weir or bar, built up by the boulders, dropped by the river where the sudden reduction of velocity occurs. The headwork is unique, consisting of a canal head regulator only, built to stand 60ft. of water above the crest at full flood, the natural weir ensuring an ample supply of water in the lowest condition of the river. It may be noted that the headworks of the Upper Swat Canal are similarly situated.

strengthening and upstream extension during the ensuing twenty years.

DEBOUCHMENTS FROM THE HIMALAYAS: SITES OF WEIRS.

Merala Weir, on the Chenab—Fig. 2—was built in 1907. It is at a very difficult place, where the numerous channels of the river, the fanning out on its debouchment from the Himalayas, meet again to form one main channel. The site must have been very skilfully chosen by Sir John Benton and Mr. Sidney Preston, for otherwise some outflanking would have occurred. The floods of 1892 and one about ten years later were calculated to have reached at Khanki a flow of 500,000 cusecs. The discharge there now includes that of the diverted Bhimbar, some 50,000 to 60,000 cusecs. Since Merala, where, as already noted, a discharge of 750,000 cusecs was measured, is some 35 miles upstream, while the flood was a very sudden one, it is probable that the flow at Khanki did not exceed 600,000 cusecs.

The weir at Rasul, on the Jhelum, built in 1902, is

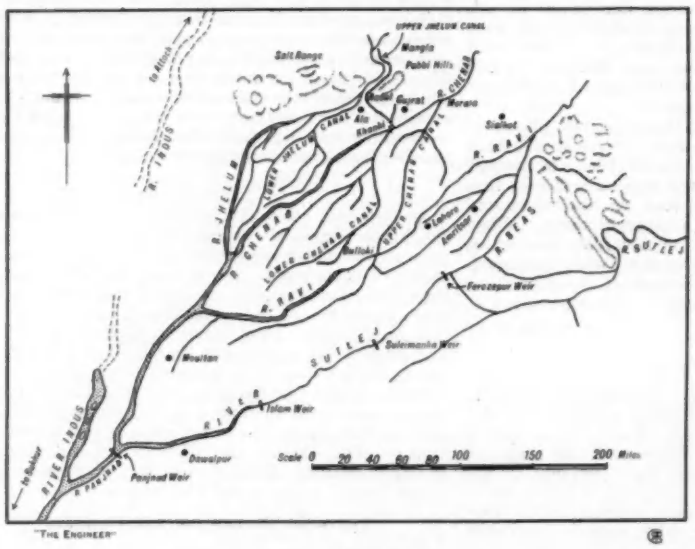

FIG. 2

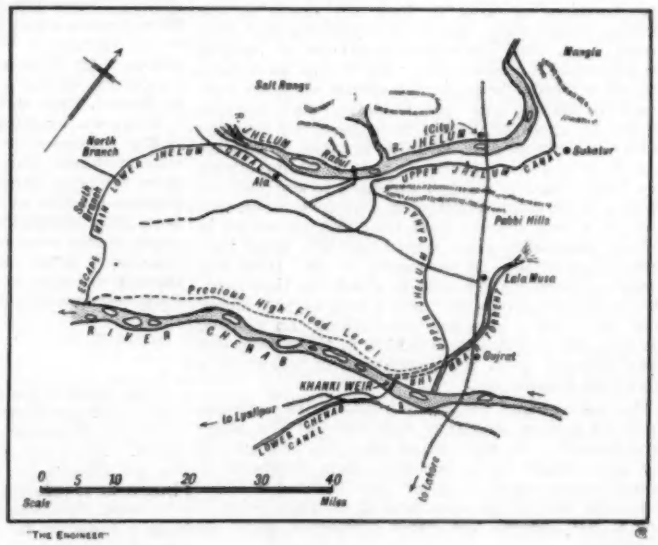

FIG. 3

THE PUNJAB FLOODS OF AUGUST, 1929.

On August 17th, 1929, news was received that the natural dam which had formed on the river Shyok—see Fig. 1—which is one of the upper tributaries of the Indus, had given way. Soon afterwards the discharge of the Indus at Attock attained to a million cusecs, with an afflux of about 6ft. at the railway bridge and, upstream of the bridge, a lake formed, 25 miles long by 5 miles wide. At Khalesar, on the river Shyok, near Leh, the flood reached to 50ft. above a 43ft. gauge, which had been set up there, or a depth of 93ft.

At Attock the flood was 4ft. or 5ft. lower than the record flood of 1882 and there was no flooding at Naoshera, where, however, the water backed up to some 20 miles upstream. Akora and Jehangir were partly flooded and were evacuated.

This flood was, of course, one which diminished in intensity with its passage downstream, but had its passage at Sukkur coincided with floods caused by heavy rains in the basin of the Indus and its great tributaries the results might have been disastrous. It seems, on the other hand, that although the Shyok flood contributed to the volume of that shortly ensuing, it had, by its action in scouring the sand-banks out of the bed of the Indus, a beneficial effect in preparing the way for the greater flood which was about to come.

The river Shyok rises in the Korakoram range, in which there are five or more peaks exceeding 26,000ft. in altitude. After flowing southward for about 100 miles the river bends sharply to the north-west and flows nearly parallel to the Indus for about 150 miles, direct distance, before its confluence with that river. Glaciers drain into it, every tributary ravine being glacier filled in the winter. There is always a risk of large masses of ice slipping into the river and damming it. The dam which was formed by glacier ice in 1928 retained a lake which, just before the dam burst, was 9 miles long, half a mile wide, and 500ft. deep at the dam. A similar dam which formed in 1841 impounded a volume of water computed as more than 22,000 million cubic feet.

In similar fashion, but retained by a dam formed by a landslip, a volume of water computed as 19,000 million cubic feet, was formed on the river Sutlej in 1762, causing the river to change its course.

THE RECORD FLOOD OF AUGUST, 1929.

On August 24th, 1929, heavy rain began all over the Indus catchment and lasted until the 28th. Amandara, where are the headworks of the Upper Swat Canal, had a very large flood on August 25th and another which reached its peak about midnight on the 27th–28th. At Abazai, where are situated the headworks of the Lower Swat Canal, the flood was probably a record one. The water reached to within 9in. of the regulator parapet, or 4ft. 3in. higher than the maximum flood level for which the works were designed, and to within a foot of the parapet of the canal regulator. Below the river regulator sluices there was an enormous standing wave and nearly double the discharge for which it was designed was passing over the weir. The whole discharge was double that allowed for in the design. The Amadara training works stood, though waves washed over them. Bunds were breached in three places. At Attock the water rose to 7ft. above the 1882 record.

At Abazai the wings of the weirs, similarly attacked, cracked and leaked, but were not destroyed. All pitching, both upstream and downstream, was swept away. Below Abazai Weir 1500ft. of a native or indigenous canal was wiped out.

At Rasul the flood carried away a part of the weir, leaving a gap in bay 3 and causing damage also in bays 4 and 5. Some 600ft. of the weir was lost, a not very serious matter in relation to the size of the work, the foundations and towers being undamaged. The flood discharge was 50 per cent. greater than that for which the work was designed.

At Mangla—Figs. 2 and 3—the water rose to 2ft. above the top of the roadway parapet, or 8ft. above the high flood level for which the work was designed, and the regulator was outflanked on both sides. The earthwork connections with the sides of the valley were washed away and a good deal of pitching removed; the main masonry work was, however, undamaged.

ISLAM WEIR.

The falling flood caused the most serious damage to an irrigation work that has been experienced in the Punjab, by carrying away six of the twenty-four bays of the Islam Weir—Fig. 2—one of the five weirs of

the Sutlej Valley project, which commands a million acres with an annual irrigation of 530,000 acres. Designed for a flood of 300,000 cusecs, the weir had already safely passed a flood of 225,000 cusecs. It is sited on a cut-off, and there may have been retrogression of levels up some runnel scoured in softer soil, which accentuated the attack on the work; this being suggested by the fact that after the flood the water was at the same level below as above the weir. It is expected that it will be possible to repair the damage before next flood season, but it will be difficult to supply water to the canal.

There are two weirs upstream, at Suleimanka and Ferozepur—Fig. 2—and it is probable that, unless the river is unusually high in the dry season, it can be drained from the reach above Islam into the canal, so that the breached portion can be rebuilt in the dry.

Widespread Character of the Floods.

At Attock the Indus rose to 7ft. above the record of 1882, or some 11ft. to 12ft. above the Shyok flood of August 18th. There were very great floods in Sind. Dozens of road and railway bridges in Kashmir, the North-West Frontier Province and the Punjab were destroyed and roads and railways breached in many places. There were also floods, all giving record discharges, in the rivers Indus, Swat, Kabul, Jhelum, and Chenab.

In Hyderabad, Sind, the area affected by the floods was about 4418 square miles with a population of 573,000. Estimates of losses were:—Damage to houses, 6,22,500 rupees; to crops, 13,66,750 rupees; to grain and other property, 51,000 rupees; loss of cattle, 1,35,000 rupees; a total of 21,75,250 rupees. Three lives were lost.

In the Thar Parker district the area affected was 12,084 square miles, with a population of 356,000. Estimates of losses were:—Damage to houses, 6,34,000 rupees; crops, 25,44,000 rupees; grain and other property, 12,000 rupees; cattle, 6,92,000 rupees; total, 38,82,000 rupees. No lives were lost in the district.

Supplementary demands for 20,00,000 rupees for loans and 4,00,000 rupees for gratuitous relief were passed by the Bombay Legislative Council. A grant of 4,32,000 rupees was made for the repair of damage to irrigation works in Sind.

The Influence of Technique on Research.*

By Major F. A. FREETH, O.B.E., D.Sc., Ph.D., F.R.S.

The subject matter of this lecture is one which probably every one who has thought much about it will agree is of the greatest importance both to science, discovery and industry, for science and discovery advance by research, and industry is in the long run dependent on the first two. If an address of this character is to achieve any useful purpose it must embody constructive suggestions. None of the suggestions now to be put forward is really novel, but the time and the place are propitious, and if anything I say can provoke discussion and, better still, action, then I hope that you will feel that your invitation to me to deliver this lecture has not been in vain.

We scientific people run an enormous number of journals, yet I would venture to make the dogmatic statement that, in spite of this, technique travels almost exclusively by example and by word of mouth. Why does technique travel so slowly? There are numerous reasons, some of which are what the writers call very "human." In discussing technique we are dealing with a subject in which many of the commonest human emotions come into play—and we all have them. We all know, and some of us smile tolerantly at, our friend whose car is one of the finest in Great Britain irrespective of its make and age. It is emotions of this character which hinder the progress of science to a great extent. Suppose that you, as is most probable, are a tactful and charming individual, and during the course of a visit to your friend the Professor of Chemistry at the University of Pekin you tell him that the methods of regulating high temperatures at the University of Timbuctoo which you have just left are worthy of consideration and imitation. In ninety-nine cases out of a hundred you will find a considerable resistance on the part of your friend. Similarly, suggestions of altering one's own experimental methods cause—in me I know—an instant instinctive opposition. I am convinced that the above statement is generally true, and by recognising it we have gone three-quarters of the way towards removing the difficulty. Now, why do people usually resist new experimental methods? There are, I think, a number of reasons. In a very great number of cases you will find that a particular school of research has been built up on a technique devised by itself, and perfected after a long series of disappointments and difficulties. If it depends upon the particular personal skill of an individual so much the worse. So many of us are quite oblivious of our really strong points and inordinately proud of one of our second-rate accomplishments; thus when a new technique comes along there is pride in the old one and very often a real difficulty in taking up the new one. It is, for example, as you all know, almost impossible to learn some things by merely reading of them, just as you, and I am sure I, would object to be operated upon by a book-trained surgeon. Personally, I am convinced that the difficulties to which I have half-playfully alluded would be nothing like so great as they are if all laboratories of any standing possessed reasonable mechanical facilities for carrying out experimental work. It is one thing to be shown or told of something new that you cannot carry out, and a totally different state of affairs if you are able to put it instantly into execution.

Surely one of the weakest spots in research in Great Britain to-day is the totally disproportionate strength on the side of technique as against the numbers and efforts of the people who are engaged in research. This is hardly a matter of opinion; it is stark fact. I have discussed this matter with every scientist I have met, and all schools of thought have been in cordial agreement.

Generally speaking, is it too much to say that the experimental facilities of the average university or research institution in this country, industrial or not, are not nearly so effective as they could easily be. Why is this? The reasons are twofold—lack of realisation on the part of people with the power to remedy it, and a certain apathy on the part of a few of those who would benefit by it. Whilst you can generally reckon on finding a rich benefactor who will endow a chair or build a laboratory or even a university, you will generally observe that his research laboratory or institution is possessed of very little money to carry on with, and that in many cases there is no money available for the conduct of research.

I have already mentioned that, in my opinion, the general mechanical facilities for research in this country are very poor. Let us begin with a most important factor, mechanics and glass-blowers. Generally speaking, they are not good enough and, even if they were, they are nothing like sufficiently plentiful. Of course, as we all know, there are some magnificent British fine mechanics and glass-blowers, and what so frequently makes them all the more worthy of respect is the fact that they have frequently arrived at their present excellence *ab initio*, as it were. The fault, or rather the difficulty, with our own mechanics and glass-blowers is that they very seldom have a chance of handing on their skill and experience to anyone else on a systematic manner. A scientist who has not access to a good workshop does not know what he has missed, his experimental and even his mental work are handicapped by a constant succession of inhibitions due to his lack of mechanical aids. The number of skilled assistants in this country of this character could be quadrupled with enormous immediate advantage to science, and subsequently to industry.

You may ask me why is there not an outcry, a loud demand, for what I say is a crying necessity. The reason, I think, is threefold: (1) The men are not to be had; (2) there is no money to pay them; and (3) I think that the average research worker in this respect has come down to a settled despair.

Now what can be done, and what is the state of affairs in more fortunately situated countries? Let me take the case of one country with which I am really familiar—Holland. Throughout the whole of that country, in universities, technical schools, and in industry, there is an extraordinarily high standard of experimental skill available for the research worker. That has not always been so, and the present situation is no accident. It is due to the genius and foresight of the late Professor Kamerlingh Onnes. About forty-five years ago he planned an attack on the physics of low temperatures which occupied him till his death, and which is still going forward. Professor Onnes realised at the outset that an experimental technique and a standard of skill hitherto unheard of would be required, and also that he would require far larger numbers of men than could be obtained casually. He therefore started the now famous "Society for the Education of the Instrument Maker," which is a remarkable institution. It consists of a large number of people, many of whom people like ourselves would describe in Army language as "civilians," who subscribe towards the fund of the Instrument Makers' School at Leiden. The course at that school lasts about five years, and the institution is not quite self-supporting. Only those who, like myself, have had the pleasure of working with its finished products can realise their extraordinary efficiency and originality. You will see that I am shying at the word "training." Many people are obsessed by the idea that you can train nearly anybody for anything. Really effective people are not trained at all, they are allowed to develop their natural aptitude by sitting at the feet of a master. There is all the difference in the world in this distinction. Now that research in this country offers the possibility of a career, which, of course, it should, we have the occupational trainee with us in ever-increasing numbers. Now I can easily imagine someone saying, "Can you imagine any body of people in Great Britain subscribing money to an object such as the Leiden Institution and having no direct connection with science or industry?" Admittedly it is not likely, but it is by no means impossible. There is in Bristol a society,† whose labours do not receive anything like the credit they deserve, which subscribes every year a considerable sum of money to the service of research and itself has on the whole no direct connection with science. There is no doubt that a reasoned appeal to the right people in this country will almost invariably be answered favourably.

One of the tragedies of modern life is the lack of real interest of powerful people in science and research. An appalling amount of nonsense has, of course, been talked about research as a panacea, as though you could go out and bring success by hiring a few mediocrities. Bacon noted the art of discovery as deficient, and so it still is, but the cause which I am pleading now is one of the certain factors of success—and an important one. I am not here to discuss ways and means, but I am sure that you will see that this urgent public matter is taken up before long.

The only other point worth discussion is how to make a start. The answer, to begin with, is to employ foreigners if you cannot find sufficient first-class home talent, and to educate your incoming *personnel* abroad to begin with if necessary. The number of people involved is so small, and the advantages to be gained so great, that political arguments, especially in the face of the utterly illogical character they assume on examination, may be safely disregarded. There are numerous branches of science whose progress could be greatly stimulated by closer contact with others, due in almost every case to advantages obtainable by exchange of technique. I have already dwelt at some length on the natural inherent oppositions which are a part of human nature. Here a great deal can be done by insistence on travel. Once again you may tell me that this is merely a matter of money, and that no money is available. To that I would again reply that it is far more a matter of the will to conquer than finding money. We all of us suffer from the most extraordinary inertia, and very frequently are unaware of first-class work, which may be going on two or three hundred yards from us, in another department. One of the factors contributing to this is what you might call the vertical organisation of modern life. The reason for this is obvious. Science has become most extraordinarily specialised, and so has industry. It is the easiest thing in the world for any busy man confronted with a particular problem to say that is a matter for such and such a department, or such and such a section of science. The result of this is to create almost a pontifical organisation headed by the names of various sciences. I think that there is no question but that modern science lives far too much in water-tight compartments.

The question of what might be done, given existing resources and technique in the way of immediate discovery, is a fascinating one.

There is one question concerning the influence of technique on research which has occupied the attention of some of the greatest minds in history. I am referring to the technique of discovery itself. Francis Bacon, as you all know, set himself the task of devising a machine, as it were, which would enable mankind to make discoveries and to advance as it had never advanced before. As you all know, he failed, but his failure was sufficiently magnificent to remain a monument throughout the ages. I should like to venture to make a few remarks on this subject, not because I feel particularly fitted to do so, but because some kind of comment is better than no comment at all. The question is how are we to make discoveries. To answer it, of course, is impossible, but we can make some approximations. When psychology becomes an exact science it will supply the answer. In the meantime, it is of the greatest interest to examine some of the mainsprings of human endeavour. It is particularly necessary to do so at the present day when the research has become a profession. The present drift of modern life is undoubtedly against discovery. Some of you will remember that appalling picture of a great research institution which is brilliantly depicted by the American novelist Sinclair Lewis in "Martin Arrowsmith." To-day is inevitably and undoubtedly the day of the administrator, and if you look back on the history of science you will find that its great men have very frequently been poor administrators. How are we to compromise? It is largely a question of stimulus. Every man has a kind of clockwork driving mechanism which forces him through life, and I would submit to you that we have seriously to consider the mainsprings of effort when we deal with modern research. Research is primarily a matter of intellectual interest, therefore its driving force should be mainly intellectual. This demands a peculiarly paradoxical state of mind, almost religious in its aspect.

In dealing with this question we must consider first of all our own national characteristics. On the whole, Great Britain prides itself on being practical, and there is an intense desire on the part of most people to justify their work and to show that it will eventually produce something which will add to the general good of mankind. I would submit to you that the way to make discoveries is to stimulate those who are engaged in research in such a manner that above all things they should be allowed to go their own way, if they show any desire to find out what is going on, irrespective of whether it is any use or not as long as it lies somewhere in the right direction. There is a very successful Institute of Industrial Research in

* Twentieth May Lecture to the Institute of Metals, delivered May 7th, 1930.—Abridged.

† Colston Research Association.

this country, the director of which, one of the greatest men of the day, practically allows his staff to do what they like, his argument being that general compulsion is sufficiently great to prevent them wandering very far from the main path, and that any reasonable wanderings such as they may undertake will be all to the good. Considerations like this make one wonder if, to take an example, the general organisation of industrial research is right in this country. We have associations for the study of various definite industrial problems—you yourselves, for example, in the Institute of Metals. We have institutions for the study of various textiles. It is, I submit, an open question as to whether you would not obtain better results if you organised your research by divisions of science rather than by divisions of practice. Let us take metals, for example. You could bring in metals and many other things into an institution devoted to the study of high-temperature equilibria, using the word in its widest sense. I think that there is no question but that the mainspring of research should be scientific enthusiasm, and that you should judge a man far more by the quality of his work than by the results it produces. Modern life, especially industrial life, offers such glittering material prizes to the administrator that we must endeavour to find a stimulus for the scientific research worker proper. This stimulus I put to you should be mainly intellectual.

The Coal Situation Abroad.

THE reorganisation of the coal mining industry has already achieved results that give promise of more being accomplished when the work now begun is completed. Yet it is quite easy to exaggerate the importance of those results in view of the fact that they are largely dependent on temporary causes, and the more the matter is investigated the more evident does it become that there can be no salvation for the colliery industry except by some agreement amongst different producing countries. The reasons for this are set forth in a well-considered report by the Comité Central des Houillères de France, which discusses the situation mainly from an international standpoint, and the report is therefore of special interest to all concerned in coal exports. The past year was a good one for the coal trade. In France the consumption was the highest yet recorded. There was consequently an increase in the home production, and a considerable augmentation of coal imports, from which Great Britain chiefly benefited. The coal trade seemed to have turned the corner, and as imports continued to improve during the first two months of the present year, there was reason to hope that a period of relative prosperity had definitely set in. Nevertheless, the coal trade improvement coincided with an unusual industrial activity, which is not being maintained, and there is some risk of this source of coal consumption undergoing a decline. What occurs in France is happening in all countries which import coal. There is an organised policy of import restrictions, which aim at adopting every method of fuel economy by utilising hydraulic power and the poorer qualities of home coal, peat, and lignite, which are generally abundant. This has failed, so far, to have any appreciable effect upon the demand for the higher grade coal. Hydraulic enterprise has been hampered by the necessity of sinking huge capital at a time when money was dear. There are many hydraulic engineers who believe that hydro-electric installations cannot compete under satisfactory conditions with the heat power stations that are being erected in the colliery districts, and with the use of pulverised coal of poor quality that would otherwise encumber the collieries, these latter are distributing electricity under conditions of economy that are hardly possible by other means. The various methods of dealing with coal by low-temperature carbonisation, by catalytic processes, and by the long-distance distribution of gas, have not yet reached the same degree of economy, and now that the collieries have attained a high degree of technical development, and the cost of bringing coal to bank has been reduced to a minimum compatible with the wages paid, there is not likely to be any change in the present system of marketing coal abroad. The efforts to economise consumption by a better utilisation of coal can have no effect upon exports under normal conditions, because this economy cheapens the production of manufactured goods, and by selling more of them, more coal is required. This has been notably the case in several industries. The present slackening foreign demand for coal, due to the industrial relapse, is attributed to general economic causes.

Since the miners' strike in 1926 showed continental countries the necessity of providing as much as possible for their own requirements, there has been a steady increase in coal output, which now so far exceeds consumption that the problem of rationalisation has become as urgent at the collieries as it is in other industries. Last year there were augmentations in all countries, except Belgium, varying from 5 per cent. in France to nearly 14 per cent. in Poland. The coal had to be disposed of somehow, and the methods employed were sometimes disastrous, to the extent that more or less disguised dumping again proved a failure for everyone concerned. So heavy were the losses on coal exported from Rhenish-Westphalia that owners had to raise the price to home consumers by as much as 2·45 marks per ton in order to make up for the deficit. Such an experience is not likely to be repeated. The German metallurgical industries are under a cloud, and they cannot support such a load. Continental coalowners affect to believe that the Coal Mines Bill in Great Britain is tending in the same direction. They affirm that "the whole internal economy of the United Kingdom" will have to bear the burden of assisting those coalfields where reduced working hours would threaten miners' wages. This, they say, is dumping, whether disguised or not. British coalowners have already done well with their policy of collaboration and State interference cannot do better. This is the theme of continental coalowners, who, contrary to the experience in all other industries, declare that they should be left alone to look after their own business and arrange amongst themselves as to what should best be done in their common interests. So far, even the Geneva Conferences have failed to settle upon any general policy acceptable to everyone. There can be no uniform hours of labour in the mining industry, because the conditions of work in the continental coalfields are not always the same. In the Ruhr the coal output was increased by an augmentation of working hours. Generally, miners do not seek to secure the same pay by working shorter time, and colliers in the north of France will not run the risk of losing work through competition from the Ruhr and other districts where the costs are lower. On the Continent there is no surplus mining population as in Great Britain. In Belgium the smaller output last year is attributed to a shortage of labour through men going into the metallurgical trades. The conditions of the colliery industry in Great Britain and on the Continent are in strong opposition, owing to labour, geological, and geographical causes, and it is difficult to see how they can be conciliated without taking into consideration so many factors as to render any general arrangement practically inoperative.

Yet it is clear that some arrangement must be come to if the coal trade is to be established upon a sound and durable basis. The Comité Central des Houillères de France looks upon the future with some misgiving, and declares that the rising curve of coal consumption has begun to fall, as the result principally of the industrial set-back over the whole of Europe. It believes that the salvation of the coal mining industry lies in a rationalisation of output and sales, presumably upon the lines of what has been accomplished in the steel trade. Anything in the nature of dumping that implies higher cost to the home consumer must be avoided. The capacity of production is so much in excess of present requirements that the output must be adjusted to the needs, and continental coalowners affirm that that can only be accomplished by an international agreement which will give to each producing country a proportionate share of the trade. This appears simple enough, but is much more difficult of realisation than it seems. There is no comparison, for example, between France, which does not produce three-fourths of the present home requirements in coal, and Germany, which has a large surplus of fuel for export, and Poland, which depends almost entirely on foreign buying. There are also geographical considerations which give to certain countries special facilities for marketing their coal. Any arrangement, therefore, must be a compromise. One has been come to between Germany and Poland, whereby the latter country is able to send a certain quantity of coal into Prussia. Rhenish-Westphalian coalowners cannot compete with the Poles in supplying fuel to the eastern provinces, and in return for the facilities offered to Poland, that country has given to Germany certain compensating commercial advantages. These partial arrangements are preparing the way for other agreements that can only result from a more effective collaboration in the colliery industry. The British organisation is regarded on the Continent as an example to be followed. It has placed British coalowners in a strong position to negotiate with foreign producers. They have arranged with Poland for a more rational marketing of coal in Scandinavia, and there is no doubt that a series of agreements of this kind will eventually give to the coal trade a stability that it lacks at present. This is as far as British coal owners can reasonably go. They cannot follow continental producers who seek to organise a cartel, whereby foreign markets will be apportioned to them. If they did, it would deprive the British owners of their privileged position as exporters of coal.

THE INSTITUTION OF WATER ENGINEERS.

THE Thirty-fifth Summer General Meeting of the Institution of Water Engineers will be held in London on Wednesday, Thursday, Friday and Saturday, 28th, 29th, 30th and 31st inst. The Institution headquarters during the meeting will be at the Hotel Russell, Russell-square, W.C. 1.

The following programme has been arranged. On Wednesday, May 28th, the General Meeting will be held in the Lecture Theatre of the Institution of Civil Engineers, Great George-street, S.W. 1, when an official welcome will be extended on behalf of the Metropolitan Water Board, by the chairman, Sir William Prescott, M. Inst. C.E. Then at 10.30 a.m. the chair will be taken by the retiring president, Mr. Frederic William Macaulay, M. Inst. C.E. The Premiums awarded by the Council for papers read during 1929 will then be presented, after which the new President, Mr. Henry Edward Stilgoe, M. Inst. C.E., Chief Engineer, Metropolitan Water Board, will be installed, and read his Presidential Address. Papers No. 1 and 2 on the following list will then be discussed. In the afternoon at 2, papers Nos. 3 and 4 will be considered. The Thirty-first Annual Dinner of the Institution will be held at the Park Lane Hotel, Piccadilly, W. 1, at 7 for 7.30 p.m.

On the Thursday, visits will be paid to works of the Metropolitan Water Board in the Thames Valley, while on the Friday there are to be visits to works of the Board in the Lee Valley, &c. On the Saturday, an inspection will be made of the meter-repairing and fittings-testing shops, also the coal-testing laboratory, and specimens of water mains, pipes, &c., affected by electrolysis and graphitic deterioration, at the offices of the Metropolitan Water Board, New River Head, 173, Rosebery-avenue, E.C. 1.

LIST OF PAPERS.

(1) "The Hampton, Kempton and Walton Pumping Stations and Filtration Works of the Metropolitan Water Board," by H. F. Cronin, M.C., B.Sc., A.M. Inst. C.E., A.M.I. Mech. E.

(2) "The South Teign Works of the Torquay Corporation," by A. Gibson Low, A.M. Inst. C.E., M.R. San. I.

(3) "The Selection and Operation of Pumping Machinery for Waterworks Purposes," by F. E. F. Durham, M.I. Mech. E.

(4) "The Steam Turbine as Applied to Borehole Pumping," by J. F. Haseldine, M.C., M. Inst. C.E., A.M.I. Mech. E., F.I.S.E.

The papers will be taken as read, in order to afford sufficient time for discussion.

A Noteworthy Artesian Well.

OUR attention has been drawn to a noteworthy artesian well which has just been completed at Slough by C. Isler and Co., Ltd., for Horlicks Malted Milk Company, Ltd.

The well was sunk down through the chalks, which were

DISCHARGE FROM ARTESIAN WELL AT SLOUGH

met with at a depth of 352ft., and the gault—first encountered at 980ft.—into the Lower Greensand, a total of 1042ft. It was lined with 75ft. 4in. of 15in. pipes, 985ft. of 12in. pipes, and 120ft. of 10in. pipes, the lower portions being perforated. No sooner was the Lower Greensand touched, which was at a depth of 1037ft. 6in., than a remarkable overflow was experienced. The water, we are informed, rose at a pressure of 47 lb. per square inch, and spurted up in a solid column, 12in. in diameter, to a height of 30ft. above ground level, before beginning to disperse.

The discharge was computed to be at the rate of, as nearly as possible, 250,000 gallons per hour, or, say, 6,000,000 gallons a day, which is believed to be the largest overflow of any in the country. Considerable difficulties were experienced in getting rid of this large volume of water, but, fortunately, it was under control.

Messrs. Islers have sent to us a photograph showing the discharge, and it is reproduced herewith.

Analysis proved the water from the well to be perfectly satisfactory. The total hardness was found to be 6 deg., while the permanent hardness was 5 deg. (Clark's Scale).

THE railway signalling profession has just lost two of its members who were prominent in that sphere of engineering until their retirement. One, on March 22nd, was Mr. J. Troughton Roberts, who was from 1912 the signal superintendent of the London and North-Western, and then, until his retirement in June, 1927, of the Crewe Division of the London, Midland and Scottish. The other, seven days later, was Mr. A. F. Rock, who from 1902 until soon after its absorption into the London, Midland and Scottish was the telegraph superintendent and electrical engineer of the North Staffordshire.

EXAMPLES OF TECHNICAL PHOTOGRAPHY

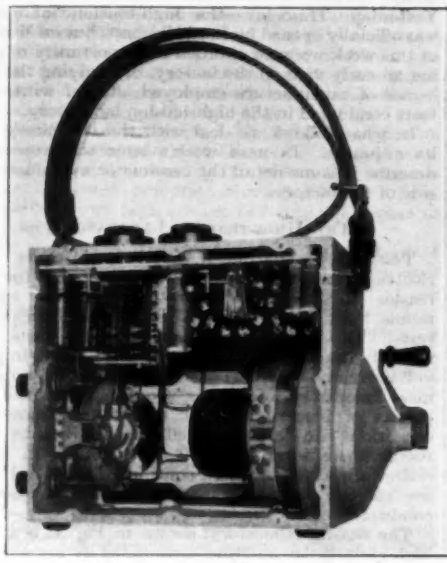

FIG. 1

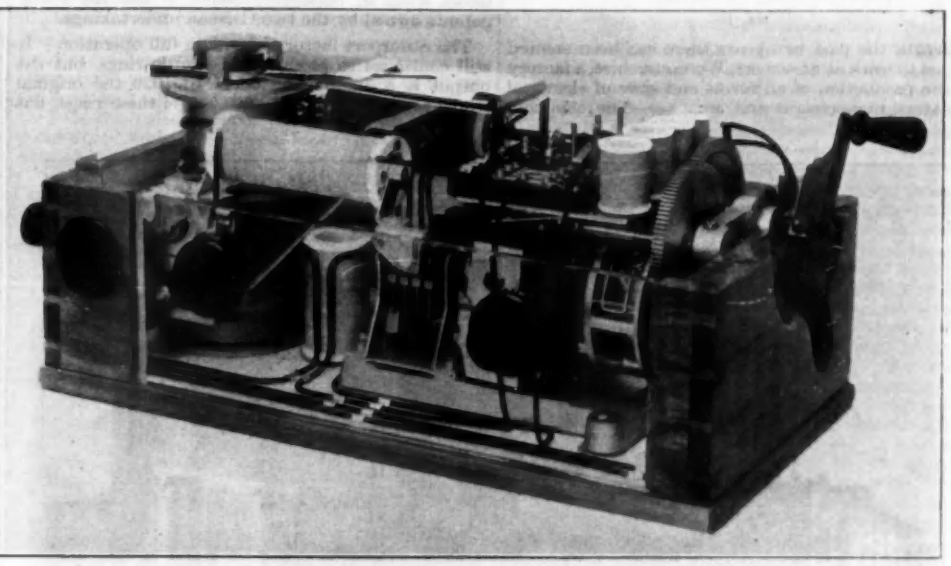

FIG. 2

Two Engineering Photographic Difficulties and Their Solution.

By A. W. SWAN.

Two problems continually perplex engineers who require to have photographs taken of their apparatus. The first is to provide a photograph which shows the interior of a particular machine or instrument without either glare or cross shadows, and the second is to show a reflecting surface, such, for instance, as a switchboard panel or some mechanism with a glass front, without unnecessary reflections. Both problems can be solved.

Where it is necessary to look right into a machine or instrument, it is clear that the light must proceed in a direction parallel to the line of sight from camera to object, since if the source of light throws its beams in a direction at an angle to this line, the nearer parts will throw shadows over the further parts that will be visible in the photograph. It is impossible to mount a lamp immediately behind the camera, since the camera itself would cast a shadow upon the object to be photographed, so that the solution of the problem is the provision of indirect lighting so arranged that the beams are thrown in the required direction. This can be accomplished by following the arrangement shown in Fig. 2. The white screen behind the camera may be of any convenient material, and there is no need for any elaborate method of suspension.

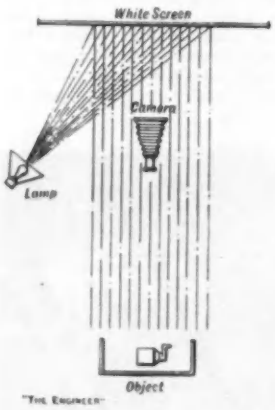

FIG. 3

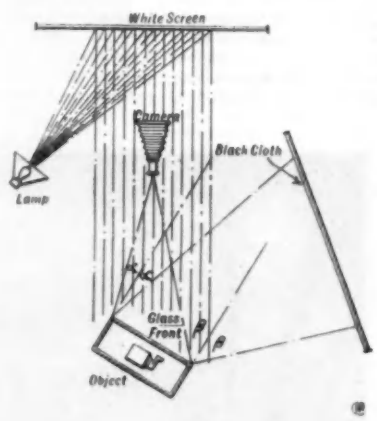

FIG. 4

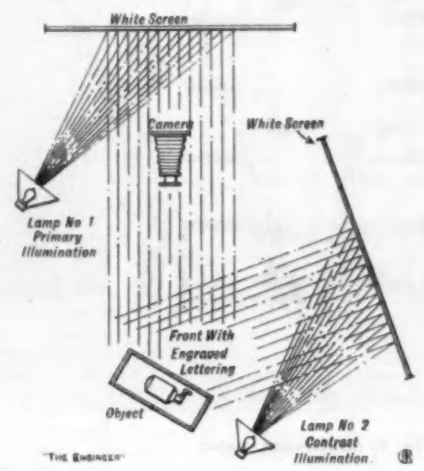

FIG. 5

In a photograph of the type under discussion, the camera as a rule is fairly close to the object. If that object is fairly deep from front to back, the lens must be well stopped down, say, to F 32, to give the required depth of focus, since if the lens were focussed on a plane halfway back when at, say, F 6·3, the front and rear would both be out of focus. The use of the lens, however, at a stop of F 32 or F 45, calls for a fairly long exposure, even with a good degree of illumination, and if the light is to be indirect, as suggested, it is most important that lamps of adequate power be provided to shine on the screen. The writer finds a 500-watt gas-filled lamp, pre-focussed, in a polished metal reflector, mounted on a portable stand, very satisfactory. It is advisable to have two lamps so as to be able to alter the illumination slightly.

Since conditions vary so greatly, it is difficult to quote times of exposures, but the writer finds that using one such light, the camera being about 3ft., and the screen about 6ft., from the object, the exposure is in the neighbourhood of one minute at F 16, using cut film of an "H and D speed" of 250.

The photograph reproduced in Fig. 1 illustrates the principles described above. It will be noted that one can see quite clearly all the details right inside the case of the instrument, which is, by the way, a "Bridge-Meg" resistance tester. The complete absence of shadows is not due so much to the fact that the light is diffused, as to the fact that the illumination proceeded in a direction parallel to a line between the lens and the instrument. The shadows all lie behind the wires, &c., when seen from the camera, and hence do not appear on the photograph, though visible to the eye of anyone standing to one side of the camera.

The second problem, that of taking photographs of instruments mounted on slate switchboard panels or instruments with glass fronts, without showing extraneous reflections, is solved very simply, as shown by Fig. 4. All that is necessary is to hang a black cloth at a position from which the camera can be seen in the reflecting surface. It is obvious that as far as the camera is concerned, the glass or slate is now merely reflecting a black cloth. As this is merely darkness visible, there are no bright reflections to appear, and the result is what one desires. Care must be taken, by the way, to see that the black cloth is of adequate extent horizontally and vertically. The screen in the diagram illustrates this point.

Fig. 4, which shows a special "Bridge-Megger" testing set, built with a glass front for the authorities at the South Kensington Science Museum, illustrates what can be accomplished by the method described above. The glass front looks like glass, but shows no undesirable reflections.

It frequently happens that the object photographed bears on the front a name-plate with engraved lettering. With the straightforward lighting scheme shown in Fig. 3, this lettering would not show, since the light comes from the direction of the camera and there is no contrast. In order to provide the necessary contrast lighting, a modification of the scheme—shown in Fig. 4—may be usefully adopted. This arrangement is shown diagrammatically in Fig. 5, and it will be noted that a second white screen takes the place of the black cloth and that there is a second lamp to illuminate this screen.

When the apparatus to be photographed has a glass plate at the top and engraved name-plate below, or *vice versâ*, the arrangements shown in Figs. 4 and 5 may be combined without difficulty, the black cloth being placed at such a height that it will cut off light from the glass plate so that the latter will not show undesirable reflections and the second white screen at such a height that it will illuminate the engraved name-plate without throwing light on the glass. The result of this combined arrangement is shown in Fig. 6, in which it will be observed that the lettering shows plainly and yet there are no reflections apparent on the glass.

FIG. 6

A DRYING cylinder in a Lancaster factory exploded on account of over-pressure. It was used in a process which evolved corrosive fumes and it is assumed that corrosion rendered the steam relief valve ineffective, while the reducing valve had been tampered with and the trap on the drain prevented the escape of steam. In commenting on the subject, the Engineer Surveyor-in-Chief, Board of Trade, says:—The fittings in connection with this drying cylinder included a reducing valve to lower the steam pressure from that of the boiler to that required for the safe working of the cylinder, and relief valves on the cylinder to give warning when the safe working pressure was exceeded. If these fittings had been maintained in an efficient working condition and had not been tampered with, they would have provided satisfactory safeguards against overpressure. With steam plant in which it is known that, owing to the nature of the process, chemical fumes that are corrosive to the metal of the apparatus and its fittings are present, the automatic safety devices, such as reducing and relief valves, should be placed where the fumes cannot come in contact with them and render them inefficient. There are, however, metals or alloys which are immune from corrosion by acid or other fumes and the use of such metals would have protected the fittings in this case from the action which rendered them inoperative.

The Manufacture and Testing of Electrical Insulators.

No. I.

WITHIN the past two years there has been erected and set to work at Stourport, Worcestershire, a factory for the production of all forms and sizes of electrical insulators in porcelain and steatite. The company operating the factory, Steatite and Porcelain Products, Ltd., derives its origin from a business established in 1907 at Earlsfield, London, for the manufacture of magnesia rings and nozzles for the incandescent gas mantle industry By 1928 the business had outgrown the capacity of the site, for it had been developed in the direction of supplying electrical insulators, particularly of the type refractory to changes of temperature.

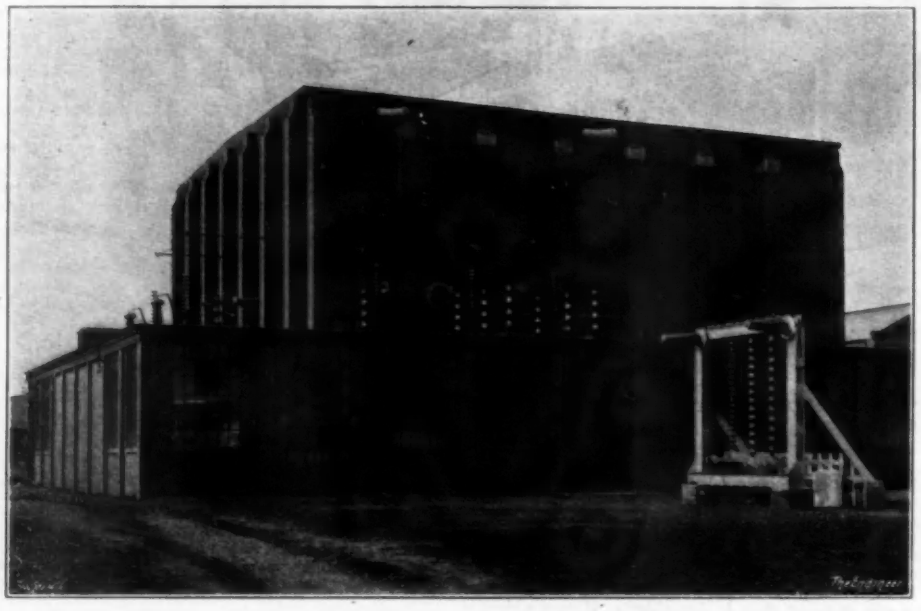

FIG. 1—THE HIGH-TENSION LABORATORY OF STEATITE AND PORCELAIN PRODUCTS, LTD.

In seeking new ground for the factory, it was decided to extend the range of manufacture to cover all forms of ceramic electrical insulators. In conjunction with Imperial Chemical Industries, Ltd., and Falk Stadelmann and Co., Ltd., the Stourport factory was erected and equipped, and arrangements were made with two German firms, the Hermsdorf-Schomburg and Steatit-Magnesia companies, for the manufacture of porcelain and steatite electrical insulators with an exclusive licence to use the many patents owned by the two German undertakings.

The Stourport factory is now in full operation. It still continues to produce gas mantle rings, but the output is a diminishing one. In 1920 the original works turned out over 80,000,000 of these rings, but with the increasing use of eletcric light the present output has fallen to 36,000,000. The factory has, however, much more than compensated for this reduction by turning its attention to the manufacture of electrical ceramic ware, in which the range of its products extends from small low-tension articles, such as ceiling roses, switch bodies and other domestic equipment, to insulators and bushings for voltages up to 220 kilovolts. Some high-tension bushings of porcelain in one piece 8ft. or 9ft. in height and 3ft. or over in diameter may be taken as representing the present upper limit to the factory's production.

The factory naturally includes full equipment, not only for making electrical insulating goods, but also for testing them mechanically and electrically before despatch. In addition, it is provided with a high-tension research laboratory, in which investigations are carried out on the products of the factory under various normal and abnormal conditions. Yesterday—Thursday—the high-tension laboratory was officially opened by Lord Melchett, but on Monday of this week we were afforded an opportunity of paying an early visit to the factory, of studying the processes of manufacture employed, and of witnessing tests conducted in the high-tension laboratory.

In what follows we deal with the laboratory and its adjuncts. In next week's issue we propose to describe in some detail the ceramic or manufacturing side of the factory.

THE HIGH-TENSION LABORATORY.

Tests on insulating material must cover both electrical and mechanical properties, and for this reason the research laboratory contains special rooms, both for high-tension electrical and mechanical tests. The high-tension room in which tests with normal frequency, high frequency, and impulse voltages can be carried out has adjacent to it a mechanical laboratory, and a fog room in which the properties of insulators under the worst atmospheric conditions can be ascertained. In addition to these rooms there is an open-air testing field in which endurance tests with high continuously applied loads are carried out under actual normal atmospheric conditions.

The testing laboratory, shown in Fig. 1, is a large high rectangular building surrounded by lower wings. The high-tension room itself has a floor area of 4300 square feet and a height of 45ft., the side buildings having a floor area of approximately 3200 square feet. A perfectly dark room was necessary for the observation of corona and other discharges. To this end windows could not be incorporated in the design of the main building. Very large doors have been substituted through which the room can be efficiently ventilated. In the side buildings, where experiments are carried out which do not involve the observation of discharges, large windows have been included. In the room where insulators are subjected to tests for observing the effects of fog and dirt deposits, the window is arranged inside the main hall.

A single-phase 500-kVA generator feeds a transformer set consisting of two cascade connected transformers. With these transformers voltages up to 1,000,000 volts, either between poles or against earth, can be obtained. From one transformer a bus-bar runs to the high-tension rectifier, fog room, mechanical laboratory, and open-air testing field. Electrical interlocks on the disconnecting switches to each of these rooms render it impossible to apply voltage in more than one room at a time. The isolating switches are of the open-air type, and are mounted on the roofs of the side buildings in order to save inside space. Fig 12, page 548, shows a view of the switching arrangements on the roof of the mechanical testing

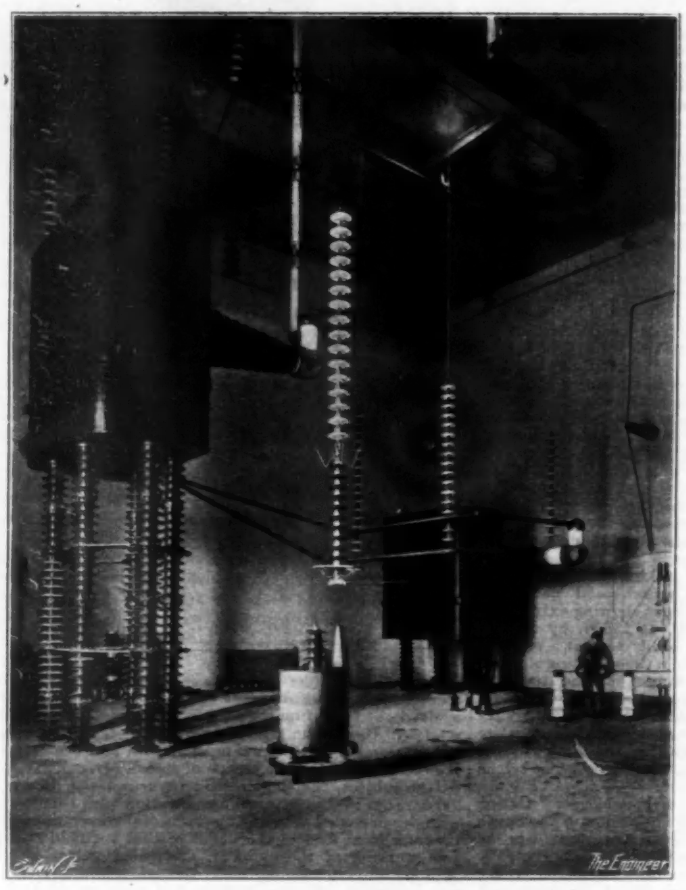

FIG. 2—TRANSFORMERS FOR TESTING PURPOSES

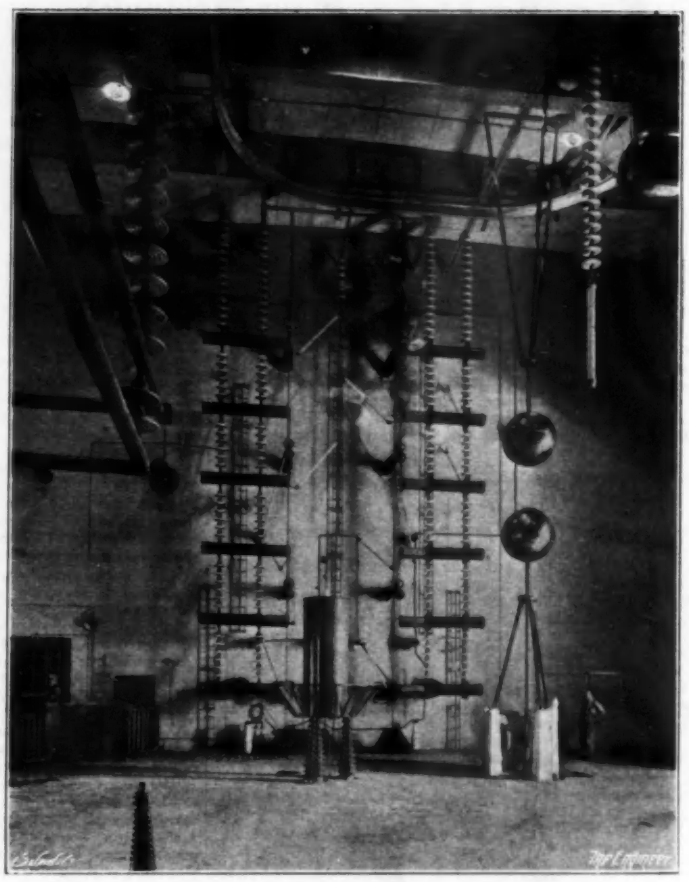

FIG. 3—CONDENSER BANK

laboratory, and Fig. 13 on the same page of those over the fog room and machine room. From the first-named switches voltage is applied to apparatus in the open-air testing field and the mechanical laboratory and from the second to the fog room and rectifier.

For the rectifier, the fog room, and the mechanical laboratory, voltages up to a maximum of 300 kV are all that is required, while in the open-air field 600 kV is available. The connections are suspended at a height of approximately 30ft. above floor level from the transformer terminals to wall bushings, which lead them to the roof switches. It is believed that this laboratory is the first to follow the example set by the power companies of placing the otherwise expensive indoor high-tension isolating switchgear in the open air.

The switches of the open-air gear on the roof of the mechanical laboratory are connected to two conductors which run to a tower at the far end of the open-air testing field. From these conductors any number of connections may be made to apparatus under test.

The following voltages are available in the testing laboratory:—(1) Normal frequency alternating current up to 1,000,000 volts R.M.S., either against earth or between poles; (2) high frequency voltage up to 1·5 million volts peak against earth with provision for doubling this voltage between poles at a later date; (3) impulse voltages up to 1·8 million volts peak.

The normal frequency voltage is obtained from two 450-kVA cascade-connected Ferranti transformers—see Fig. 2. Both transformer tanks are insulated from earth, one for a voltage of 250 kV and the other for 750 kV by means of porcelain supporting columns. By feeding the two units in parallel from the same source 1 million volts between poles is

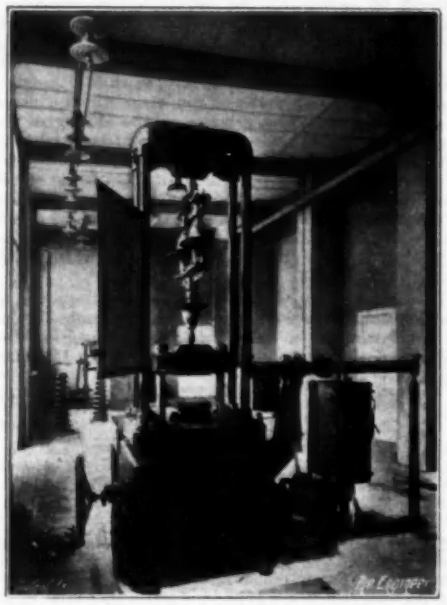

FIG. 4—30-TON TENSILE TESTING MACHINE

obtained, while the normal cascade method of connection gives 1·2 million volts against earth.

The transformers are fed by a 500-kVA 6000-volt generator. To permit of the accurate measurement of voltages lower than 50 kV a special auto-transformer can be switched into circuit to reduce the generator voltage to half its original value. The excitation of the generator is obtained from a direct-coupled exciter which is externally excited from an accumulator battery through a potential divider. This method enables the generator voltage to be regulated smoothly and with great accuracy. Arrangements are also made for reverse excitation, so that the remanent magnetism of the generator can, if necessary, be annulled and the terminal voltage of the machine reduced to zero.

For the generation of high-frequency voltage a Tesla transformer has been provided. The high-frequency circuit can be set in oscillation, either by means of alternating-current or direct-current excitation. In the first case the condensers are charged and discharged 100 times per second across a specially designed quenched spark gap and in the second case the condensers are charged by means of unidirectional current—rectified alternating current—and the rate of charging can then be reduced to any desired figure, for example, to give one discharge per second. Each of these two methods has its advantages. For measuring purposes it is held to be preferable to have a regular and easily controlled series of discharges and for this direct-current charging is employed. The condensers are then so charged that, say, one spark per second passes across the primary spark gap. The visible effect of the damped secondary oscillations is in this case so weak as often to be difficult of observation by the eye. If, however, it is desired easily to observe the effect in the secondary circuit, it is preferable to use alternating-current excitation and 100 primary discharges per second, giving 100 secondary wave trains per second. The eye is capable of holding a light impression for about one-seventh of a second, so that the impression of the previous discharge is still present when the next one occurs. The secondary winding of the high-frequency transformer is oil immersed. In order to keep a reasonably loose coupling and low losses the primary is entirely air insulated. Fig. 3 shows the condensers which are used for the high-frequency equipment and the surge generator. Only the lowest four condensers are normally used for high-frequency tests. Change-

FIG. 5—ENDURANCE TESTING MACHINE

over from high frequency to the impulse circuit is effected by a simple rearrangement of bus-bar connections.

In addition to high-frequency tests which imitate the conditions which occur in high-tension lines, when parts of the system are caused to oscillate at their natural frequency due to shock excitation from lightning surges, &c., impulse tests which imitate the direct effect of the lightning stroke itself are of the greatest importance. The impulse plant in the high-tension laboratory incorporates the Marx voltage multiplication impulse circuit. The general lay-out of the condensers, sphere gaps, and charging resistances will be seen in Fig. 3. The condensers are charged in parallel through high resistances and discharged on to the object under test in series on the

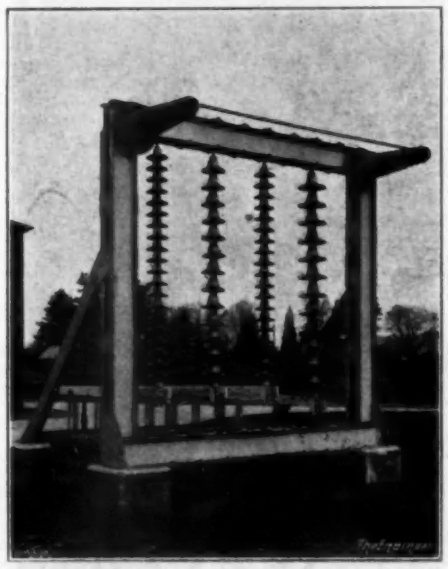

FIG. 6—OPEN-AIR ENDURANCE PLANT

simultaneous breakdown of the intermediate spark gaps. Voltages in excess of 1,800,000 volts have been obtained, and are believed to be the highest voltages every produced artificially in this country.

The method of obtaining the unidirectional current for charging the condensers is of interest. Having regard to the high stresses applied to the rectifier when used in conjunction with the impulse generator, it was decided not to use thermionic rectifying valves, but to employ a Delon mechanical rectifier. Such a rectifier, when caused to revolve at the correct speed, enables two condensers to be charged up against earth, so that a voltage which is double the peak voltage of the transformer supplying the current for rectification is obtained. The rectifier is direct coupled to the generator supplying the transformers in order to avoid the necessity for synchronisation.

THE MECHANICAL LABORATORY.

For testing the mechanical strength of insulators two tensile testing machines have been installed. Although for insulators with cemented-in pins small tensile machines are sufficient, since ultimate strengths of over 10 tons are rarely obtained, the company's standard design of spring-ring suspension insulator requires a considerably larger machine. The 30-ton tensile testing machine installed for this purpose is shown in Fig. 4. This machine has been specially designed for mechanical and electro-mechanical tests on insulator units or on lengthy strings of insulators. It can also be used for compression tests up to 30 tons. Compression test pieces are regularly broken on this machine as a continuous check on the quality of the material passing through the works. The tensile strength of the test-pieces is usually determined on the accurate 10-ton machine. For use in conjunction with this machine the company has designed and constructed auxiliary parts by means of which torsion and bending tests can be carried out on all types and sizes of insulators. It should be noted that tests are carried out, not only on complete insulators, but also on test pieces fired with each batch of insulators in order that a continued check may be kept on the dielectric, tensile, and compressive strengths and other properties of the material used.

In addition to these tests, a special machine is provided to carry out the vibration tests on insulator posts specified by the Central Electricity Board. For this purpose the machine shown in Fig. 15 was designed and constructed. Another machine has also been

FIG. 7—FOG ROOM

built for testing insulator posts designed for open-air isolating switches under conditions which reproduce very closely those which obtain in practice. This machine, shown in Fig. 5, carries five columns of insulators, the centre column of which carries the rotating switch arm, and the four outer columns standard switch contacts. The switch is operated by compressed air, and may be adjusted for speed of operation and for contact pressure. The centre column is subjected to impact torsional forces, and the outer columns to impact bending and simultaneous vibration stresses exactly as in service.

Every machine in the mechanical laboratory—a general view of which is given in Fig. 14 on page 548—can be used for electro-mechanical tests as well as for the mechanical tests for which it is primarily designed. For this purpose a high-tension bus-bar runs over each machine.

The duration loading frame, Fig. 6, which is situated in the open air, must also be included amongst the mechanical testing machines. In this frame insulators are subjected under actual open-air conditions to continuous loads far in excess of normal working loads. The insulators can also be subjected to continuous or intermittent high electrical tensions.

FOG ROOM FOR FOULING TESTS.

In a special air-tight room tests on all types of insulators are carried out under conditions of heavy fog, mist, salt spray, artificial fouling by solid matter, such as smoke, chemicals, cement dust, coal dust, &c. This room, shown in Fig. 7, measures approximately 18ft. by 15ft., and is 18ft. high.

In order to obtain a heavy mist deposit on the insulators under test they are hung for a considerable time in a refrigerating chamber sunk beneath the floor level of the fog room, the internal dimensions of this chamber being approximately 4ft. by 4ft. by 8ft. deep. They are removed from the refrigerator and hung in the fog room, which is kept at a higher

HIGH-TENSION TESTS ON ELECTRICAL INSULATOR STRINGS

FIG. 8—DRY FLASHOVER AT 450 kV

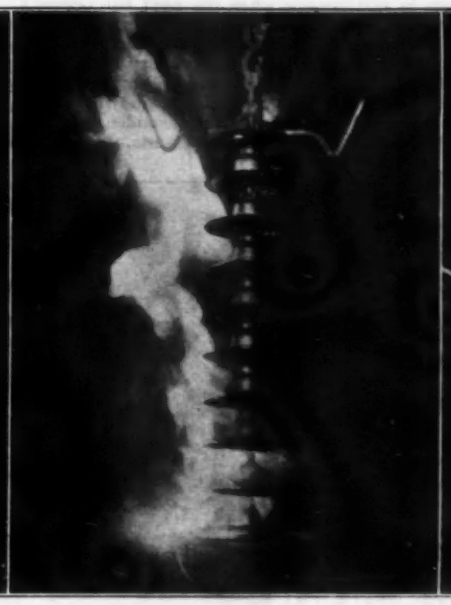

FIG. 9—POWER ARC ON SOOTED INSULATORS

FIG. 10—FLASHOVER AT 1,800,000 VOLTS

temperature and high degree of humidity—approximately 90 per cent. Dew immediately condenses on all surfaces of the insulator, exactly imitating the effects of a natural mist. If dirt deposits of other kinds are required, they are applied to the insulators before they are hung in the ice box. In special cases the humidity of the room may be obtained by atomising in the fog room sea water, salt solutions, weak acid solutions, &c.

Voltage is brought into the room through a bushing in the roof, and observations of the pieces under test are made through a large window. A special method of ventilating the room after tests is provided, so that the room can be entered without discomfort or danger to health. The fog room also contains a special smoke or sooting chamber in which insulators are enclosed and layers of soot of varying thickness deposited upon them. During the sooting process all normal working voltages up to 132 kV may be applied to the insulators or strings of insulators under test. For special comparative tests insulators can also be soiled slowly and with rain applied to them at intervals, the whole process lasting over a period of several weeks in order to obtain the same state in the insulators as is observed on units actually taken down from overhead lines in industrial or foggy areas.

AUXILIARY EQUIPMENT.

For voltage measurement a sphere gap—Fig. 11—is placed centrally in the main high-tension room, so as to be equally accessible for measurements of normal-frequency, high-frequency, and impulse voltages. The spheres are 1 m. in diameter. It is realised that the largest spheres mentioned as standard in British Standard Specification 358, 1929, are 750 mm., but for voltages higher than approximately 800,000 volts larger spheres are necessary. Particularly is this the case when measuring impulse voltages, since at gap distances greater than the diameter of the spheres errors occur, because of the fact that the impulse ratio no longer remains unity.

A runway track carrying a 3-ton hoist permits the suspension of the insulators under test in any position in the room. It is also used for lowering and raising insulators into the oil vessels for tests under oil. Large insulators may be brought on lorries through the double doors of the main room to a point under the track, from which they may be hoisted and run to any required position.

A rain frame suspended from the roof may be lowered by means of a winch to any required height suitable for raining on to the insulators undergoing wet flashover tests. The frame can be used either in a vertical or horizontal position, the latter being required for strain insulator strings. The direction of the jets can be adjusted both in the vertical and horizontal plane, so that the quantity and direction of the rain can be varied to suit any experimental requirements or test specification. Either tap water or rain water or a mixture to give any specified resistivity may be used. Rain water is collected from the roof of the laboratory and run into a tank below the floor. It is pumped to the rain jets by means of a centrifugal pump. Apparatus is available for checking the exact resistance of the water.

Transportable oil tanks are provided for tests under oil. One of them is arranged for the electric heating of the oil to comply with many test specifications, and is so sealed that, for example, rain can be applied to the open-air end of a transformer bushing, while the lower end is immersed in hot oil.

A study of the behaviour of insulators under the influence of power arcs carrying several hundred ampères is of exceptional practical importance. For this purpose a cable is brought into the main room from the generator, so that power arcs may be formed across insulator units or strings carrying currents up to almost the short-circuit current of the machine. Tests such as these are of particular interest to those responsible for the design of power transmission lines

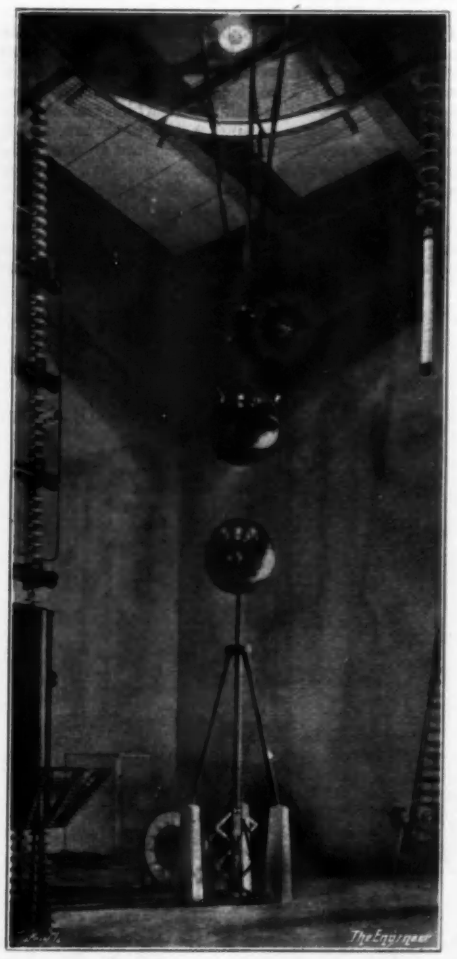

FIG. 11—SPHERES FOR MEASURING HIGH VOLTAGES

for the purpose of choosing the most suitable types of protective fitting. Not only should the suggested fittings be tested with flashovers caused by various types of voltage, but the effect of the power arc which will follow a flashover on the line merits, it is urged, at least equal consideration. During power arc tests the insulators may be subjected also to mechanical stress.

Although in an experimental laboratory it is often difficult to include all the safety devices which are essential in a routine testing room, every reasonable precaution is taken for the safety of those working in all rooms of the high-tension laboratory. Double safety devices are fitted in every position of possible danger. Rooms or parts of rooms in which voltage is present or would be present on the closing of the main circuit breaker cannot be entered without automatically causing the circuit breaker to fall out, and at the same time preventing it from being closed until the door or gate in question has been reclosed. It is impossible to apply voltage to two rooms simultaneously, and impossible to close the circuit breaker unless all the doors of the room under voltage are closed.

In Figs. 8 to 10 we illustrate a dry flashover at 450,000 volts, a power arc on a heavily sooted string of insulators in a salt-mist atmosphere, and an impulse flashover on a standard string at 1,800,000 volts.

(To be continued.)

SIXTY YEARS AGO.

IN our issue of May 20th, 1870, we announced that Zerah Colburn was dead. On April 25th he had been found dying in an orchard at Belmont, near Boston, U.S.A., wounded in the head by a pistol shot fired by his own hand. Thus passed away an engineer whose abilities, as we put it, were sufficient, had they been wisely directed, to have raised him to any position that a member of the profession could reasonably hope to attain. It was a strange obituary notice, but in its strangeness it was no more than in keeping with the character of the man. He was born at Saratoga in the State of New York in 1832. As a boy he showed at an early date wonderful powers of memory, a passion for mechanics, extraordinary energy and great fitfulness of character. Incidentally, it may here be noted, although it is not mentioned in our obituary notice, that he was born with five fingers and a thumb on each hand, and six toes on each foot. In conjunction with his talents as a lightning mental arithmetician, he made good use of his deformity on one occasion to overwhelm an opponent who sought to argue that because man was supplied with ten fingers the decimal system was a natural one by which to count. In his early days Colburn was in turn an office boy, a clerk, an actor, poet, agent and an engineer. In 1857 he found his way to this country. By 1858 he was a practised writer for the scientific Press. At the request of the founder and editor of THE ENGINEER, he wrote several articles for this journal of so high a character that he was ultimately appointed to an influential position on the staff. Eventually, for a time, he occupied the post of editor-in-charge while the responsible editor and proprietor was absent on the Continent through ill-health. We took advantage of the occasion to remove a prevalent impression that at one time he had had a pecuniary interest in this journal. His articles we recorded had never been excelled in vigour, accuracy and elegance of style. Subsequently, we stated, they manifested in a few cases a lack on his part of that spirit of strict impartiality which should distinguish an influential journal. In November, 1864, he ceased to have any connection with the editorial department, although he remained an occasional contributor up to the spring of the following year. What else we said of him it is, perhaps, seemly that we should not resuscitate. His name and his contributions to the progress of engineering science are still remembered. Perhaps the hope expressed in the closing sentence of our obituary notice has come to be fulfilled, the hope that the angel of charity would efface with tender hand the record of his faults and leave for another generation the memory only of his virtues, his talents and his good deeds.

Railway and Road Matters.

SINCE the Southern Railway came into being thirty stations have been entirely reconstructed and forty substantially altered. Six extensive carriage sheds have been built and five large locomotive depôts reconstructed.

AT the seventy-second anniversary dinner on the 29th ultimo of the Railway Benevolent Institution, it was stated that 235,000 railway servants of all classes subscribed to one or other of the funds of the Institution.

IN the two years since February, 1928, the London and North-Eastern Railway has received 5160 suggestions from 2545 members of the staff. The identity of the authors is not disclosed, and that rule has done much to popularise the scheme, as the staff feels that it ensures impartial consideration. It is said that there had been a definite saving of £2250 as a result of suggestions that have been adopted.

It is proposed to improve the harbour at Weymouth, at a cost of £144,000, of which the Great Western Railway has agreed to pay one-half. The way in which the business through the port has increased may be judged from the fact that the amount of dues paid by the railway company has increased from £4000 in 1922 to over £10,000 last year. Under the scheme the pier will be reconstructed and new passenger and cargo berths made.

ONE of the items recommended by the Select Committee on the Accounts of Railway Companies which were subsequently embodied in the Act of 1911 was Table X. of the annual report. It showed the quantities of the principal materials used in the maintenance of way and works, and those selected were the number of yards of ballast, the miles of fencing, the tons of rails and the number of sleepers. It is hard to comprehend why details of the fencing should be given, and the Ministry of Transport evidently regarded the information as useless, as it is now omitted from Table X.

UNDER the heading "Safety on the Road," there appeared in *The Times* of May 7th, a letter from Colonel J. A. A. Pickard, the general secretary of the National Safety First Association, in which attention was drawn to the little-noticed announcement of Mr. Clynes on April 10th, that whilst there was in 1929 an increase of 3 per cent. in the number of street accidents over 1928 there had been an increase of 7 per cent. in the number of motor vehicles licensed. The increase in accidents is the smallest since the war; moreover, in previous years the percentage rate of increase in the number of street accidents has very closely corresponded to the rate of increase in the number of motor vehicles.

ADDRESSING a meeting of railway servants at Woking lately, Mr. Gilbert Szlumper, the assistant general manager of the Southern Railway, said that if they only added 1 cwt. to each load they would increase the wagon-carrying load by 40,000 tons per year, and reduce the mileage by 60,000 miles, which would make for a saving of £12,000 per year. There was also the question of freight shunting. If they could reduce that by 1 per cent. they could save £1000 a year. Then with regard to claims for the loss or damage of goods in transit, if they could save 1s. in the £ they could effect a saving of £2000. They had a staff of 71,300 and if each of them effected a saving of 1d. per week in the use of oil, dusters, &c., another saving of £16,000 per year would result.

IN the April issue of the *London and North-Eastern Railway Magazine* there is an article by Mr. Barrington-Ward, the superintendent of the western section of the Southern Area, on the subject of vacuum-equipped goods trains. There are two types: Class I. trains, which are fully braked and run, excluding booked stops, at 45 m.p.h.; and Class II. trains, which are partially braked and run at an average speed of 35 m.p.h. Not all the wagons in the Class I. trains have to be fully braked; they may be piped, but forty-seven out of sixty wagons must have the brake complete. The braked wagons in Class II. trains must be placed next to the engine and a train of sixty wagons must have twelve fully braked. The article concludes with the remark that braked trains perform a useful service in the operation of a railway and the tendency is for their number to increase.

IN reply to a question as to the increasing number of accidents to passengers when alighting from trains, and as to whether there was any standard width of footboard or any maximum distance of side of footboard from railway platforms, Mr. Morrison said recently that he was aware that the number of such accidents had somewhat increased, but he doubted whether many of them would have been prevented if the clearance had been smaller. Differences in the length of vehicles and the curvature of the platforms and other circumstances made it impracticable to prescribe a uniform maximum clearance, but the requirements of the Ministry with regard to the construction of new passenger lines provided that the interval between the edges of platforms and the footboards of carriages should be as small as practicable, and special attention to that point was given by the Inspecting Officers when inspecting new platforms.

THE London, Midland and Scottish Railway Company proposes to incur a capital expenditure of £5,701,000 during the current year, of which £1,825,000 will be on new lines or additions to existing lines, £567,000 on rolling stock, which includes £315,000 for wagons, £188,000 for manufacturing plant, £206,000 for road vehicles, £203,000 on docks, £164,000 for additions to the Midland Hotel at Manchester, and £2,130,000 in subscriptions to road transport undertakings. The proposed capital expenditure of the London and North-Eastern is £3,329,000, which includes £446,000 on the railway proper, £389,000 for steamboats, £87,000 for docks, and £2,000,000 for subscriptions to road transport undertakings. The £1,944,000 proposed to be spent by the Great Western includes £1,513,000 to be expended on the railway proper, £174,000 on manufacturing plant, and £150,000 in subscriptions to "other undertakings." The last are not specified and may or may not mean those for road transport. The estimate for the Southern Railway is £2,182,000, which provides £582,000 for electrification, £452,000 for other railway works, £249,000 for new steamboats, and another £800,000 for Southampton Docks extensions.

Notes and Memoranda.

AN investigation carried out by the American Bureau of Mines shows that natural gas can be cracked in a water-gas generator by making alternate air blasts and gas runs. The resultant gas is comprised largely of hydrogen.

IN the course of a paper read before the South African iron and steel industrialists, Mr. T. Nimmo Dewar said that it had been proved that coal could be got from the Witbank area which produced a good furnace coke. Nevertheless, it would receive severe competition from Natal coke.

A MESSAGE from Stockholm states that an engineer, M. Joh. Haerdén, of Stockholm, has invented an alloy said to be as light as aluminium and as hard as steel. The alloy, it is added, can be rolled or drawn to any extent, and is not affected by corrosive fluids. The Board of Trade (Kommerskollegium) has, it is said, granted an allowance for further experiments towards rendering the metal insensitive to the action of sea water, so as to make it suitable for hydroplanes, screws and other parts of ships. The strength of the new metal is given as being 30 kilos. to 40 kilos. per square millimetre, but it is hoped to increase the strength still further.

CONSTRUCTION of an electric transmission line 82 miles long and costing approximately 1,000,000 dollars for interchange of power between Louisville and Cincinnati is provided in a contract which has been signed by officials of the Louisville Gas and Electric Company and the Cincinnati Gas and Electric Company. Most of the right-of-way has been purchased, and it is planned to begin construction immediately. The line is expected to be in operation next autumn. Plans for the interconnection call for a normal capacity of 40,000 kW, with electricity being transmitted at 132,000 volts. Most of the territory traversed by the proposed line is now being served with electric power, and it is not proposed to tap it for this purpose.

MONTREAL has up to now spent more than twice the amount of money for snow removal in the streets than was expended last season. From the beginning of winter in 1929 to January 17th, the city spent 940,055 dollars, while in the corresponding period last year only 431,331 dollars had been spent, a difference of 508,724 dollars more for this season to date. As the snow removal cost from 1,500,000 to 2,000,000 dollars in former years, it is anticipated that this year the requirements for the purpose will reach 3,000,000 dollars, say, £600,000, or more. In one week alone the city treasurer paid 290,000 dollars as wages to snow cleaners; 52in. of snow fell during the past winter, as compared with 32in. last winter.

IN an article on hydraulic dredging in the *Engineering News-Record* the following figures are given as to the performances of large modern dredgers:—A 30in. suction and 26in. discharge dredger, powered with about 1600 S.H.P. on the pump, on 1800ft. of pipe line and 9ft. elevation, pumped in twenty-three continuous operating hours 53,000 cubic yards of sand and mud. The same dredger with 1250ft. of pipe line and an elevation of 8½ft. and developing the same horse-power pumped 9500 cubic yards of hard clay mixed with large clam shells in 22¼ continuous operating hours. Likewise the length of pipe line through which a dredger can pump will vary with the material, for instance, a 30in. dredger with 3000 H.P. can pump gravel through about 5000ft. of pipe line with an elevation of 6ft. to 8ft., and the same dredger can pump a sand and mud mixture through a pipe line around 15,000ft. long with the same elevation.

IN discussing accidents connected with revolving shafting, the *Drop Forger* gives the following brief description of a guard made in Birmingham. It is formed of specially impregnated cardboard, split longitudinally, so that it can easily be snapped on to the shafting by opening one end of the guard and gradually working it on to the shafting. When in position, the guard is closed by special metal clips, which are easily knocked on with a hammer. This guard revolves with the shafting, but stops instantly on contact, so that should a workman fall on it or touch it with his clothing, the guard would remain stationary while the shafting continued to revolve. The guards are clean and sightly, and have a bright steel finish; they are also impregnable against oil and grease. In addition to providing a really excellent protection against accidents, they also serve to keep the shafting clean. They are also inexpensive, ranging from 6d. to 1s. per foot in diameters of from 3in. to 6in. The inside diameter of the guard is one-quarter larger than the outside diameter of the shafting.

MUCH attention is being devoted at the present time to the question of substituting steel for timber in the underground workings of coal mines. The value of steel arches for roadway support has been proved beyond doubt, but it is not so widely known that steel props have been successful at the face under a variety of conditions when the prop tried has been of a suitable type. Colliery managers who are intending to give steel props a trial will find useful information in a report on about thirteen different types, rigid and yielding, just published by the Safety in Mines Research Board. The Support of Workings in Mines Committee, in its survey of colliery practice throughout the country, has investigated the use of steel props and recorded experience at a number of mines, and the present report—"Steel Pit Props," by T. Ashley, S. M. Dixon, and M. A. Hogan (S.M.R.B. Paper 58)—combines these records with information obtained from mechanical tests of the props made on behalf of the Committee at the City and Guilds (Engineering) College, and a general discussion of the conclusions to be drawn from the underground experience and the laboratory tests. The report contains sketches of the props and load-shortening curves for the yielding types, together with plans illustrating the systems of roof support by steel props adopted at a number of collieries. In an introductory note, the Chairman of the Committee points out that a particular steel prop may be condemned at one pit while meeting with a full measure of success at another, and it is most important that the type of prop should be carefully chosen to suit the conditions obtaining where it is to be used. The report is priced 1s. net, and may be obtained from H.M. Stationery Office either directly or through any bookseller.

Miscellanea.

A FLYING club, with two Government subsidised Moth aeroplanes, is being organised in Madras.

THE Coventry Corporation proposes to lay a high-pressure ring gas main round its district of supply at a cost of £109,895.

A NEW reduction plant capable of dealing with 60,000 tons of gold ore per month is to be installed by the East Geduld Company, South Africa. The new shaft is being equipped with two Ward Leonard electric winders.

THE Supreme Court of the United States has decreed that Chicago must finally complete its sewage disposal system by 1938, and on that date reduce its diversion from Lake Michigan to 1500 sec.-ft. in addition to domestic pumpage.

IT is proposed to put up an iron smelting works in Russia with an initial capacity of 2,500,000 tons of pig iron a year. The plant is to be supplied by an American firm and is to be capable of expansion to a capacity of 4,000,000 tons a year.

IN 35½ working days 2649 wood piles, aggregating 145,000 lineal feet, were driven for the new building of Montgomery Ward and Co. at Chicago-avenue and the Chicago River during February and March, 1929, using two pile drivers.

THE New England Public Service Company, of America, has acquired a steamship of 7668 tons for conversion into a floating power station to supply the coastal towns of Maine and New Hampshire. It is to be equipped with two 10,000-kW turbo-generators and four high-pressure oil-fired water-tube boilers.

THE preliminary scheme for the Mandi hydro-electric scheme in the Punjab contemplates a station of 36,000 kW from a head of 1800ft. The water would be diverted from the river through a tunnel 2¼ miles long by 9ft. 6in. in diameter. It would be possible to develop a further 48,000 kW from the tail water in a subsequent fall.

THE announcement is made that the Lord President of the Council has appointed Sir Ernest Rutherford, O.M., Pres. R.S., to be chairman of the Advisory Council of the Department of Scientific and Industrial Research in succession to the late Sir William McCormick, G.B.E., F.R.S., as from October 1st, 1930. Professor V. H. Blackman, F.R.S., will serve as chairman until October.

A BRITISH Compressed Air Society has been formed to promote and develop the interests of British air compressor, pneumatic tool and pneumatic appliance manufacturers. The chairman is Mr. Ernest C. Dunkerton (Robey and Co., Ltd., Lincoln); the vice-chairman, Mr. R. L. Quertier (Reavell and Co., Ltd., Ipswich); and the hon. secretary and treasurer, Mr. A. Vincent Clarke (the Hamworthy Engineering Company, Ltd., Poole). The offices of the Society are at 76, Victoria-street, London, S.W. 1.

THE construction of a new port at Quequén, the only southern port of any value between Mar-de-la-Plata and Bahía Blanca, in the Argentine, has been begun. The port will be some 5 miles long, with discharging yards with a length of between 3½ and 4 miles, while a prolongation of the railway from Necochea to Energia, to fill the present gap, is contemplated. To maintain the channel at the required depth, daily dredging of 20,000 or 25,000 cubic metres will be necessary. When the channel is properly dredged steamers of 4000 tons burden and 30ft. draught should find admission at low water. Electric cranes and other modern appliances will be purchased. A considerable and increasing trade is carried on in cattle and agricultural produce, and it is hoped that grain exports will be increased from the present 50,000 tons to over 100,000 tons.

THE Government of Madras paid a great deal of attention last year, according to *Indian Engineering*, to irrigation to get in proper order the existing irrigation works and to expand the irrigated area in the presidency. The expenditure on irrigation charged to revenue amounted to Rs. 112 lakhs. Besides, there is the Mettur project, for which the Government has now to provide Rs. 150 lakhs. The expenditure on minor irrigation works was estimated at about Rs. 17 lakhs. As regards the Tungabadra project, the expert's preliminary report is now under the consideration of the Chief Engineer. The Geologist of the Government of India will inspect the site this summer and submit his final report to the Government. The Government of Madras is also investigating the Palar irrigation in consultation with the Mysore Durbar. Five important projects are now under investigation. Estimates have been sanctioned for about 200 minor irrigation works. The district of Anantapur is receiving a certain amount of attention. The expansion of minor irrigation works will cost about Rs. 56,000.

NEWS of failure of the Alexander dam in Hawaii does more, according to the *Engineering News-Record*, than merely add to the list of misfortunes attendant upon hydraulic-fill construction. It has a broader interest, because the dam was being built with the aid of a remarkable expedient based on the behaviour of colloidal materials, namely, chemical treatment of soil by alkaline salt to flocculate the dispersed soil particles in the puddle trench and promote compaction of the soft material. Its success seemed destined to establish chemical soil treatment as a new and powerful instrument in the civil engineer's armoury. The failure of the dam may have the unfortunate effect of surrounding the method with uncertainty and suspicion, even though the accident did not involve the treated earth. From the meagre descriptions of the Alexander dam construction work so far received it appears that treatment was applied only to the earth filling of the puddle trench on either side of the cut-off wall below the original ground level. This, however, was not connected with the failure if, as the brief news account indicates, the dam was destroyed by an outbursting of unconsolidated mud from the core of the embankment above ground. Fuller details of the accident will therefore be awaited with unusual interest. If treated material was not involved in the disastrous happening, the chemical method should claim as full attention and interest as before.

RESEARCH LABORATORY FOR THE TESTING OF ELECTRICAL INSULATORS

STEATITE AND PORCELAIN PRODUCTS, LTD., STOURPORT, WORCESTERSHIRE

(*For description see page* 544.)

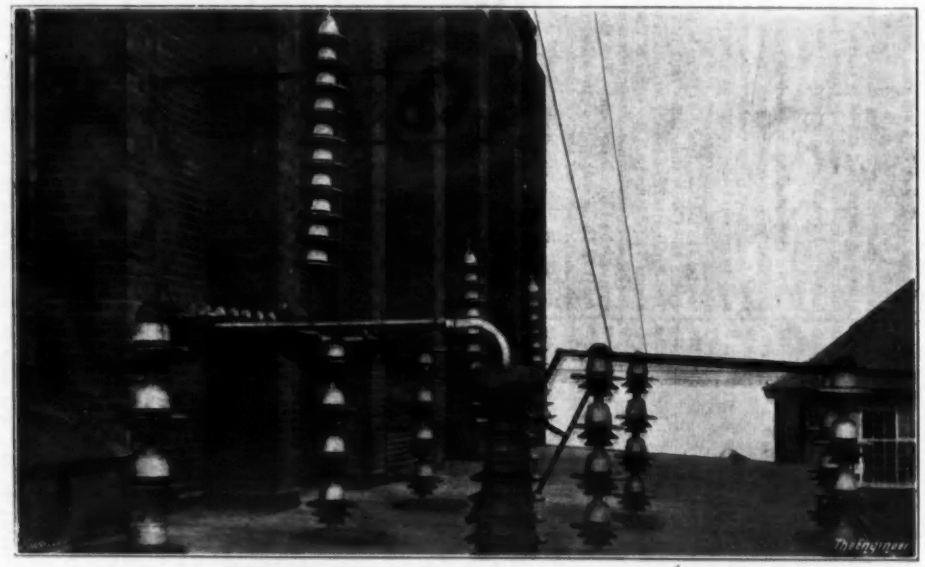

FIG. 12—ISOLATING SWITCHES ON ROOF OF MECHANICAL LABORATORY

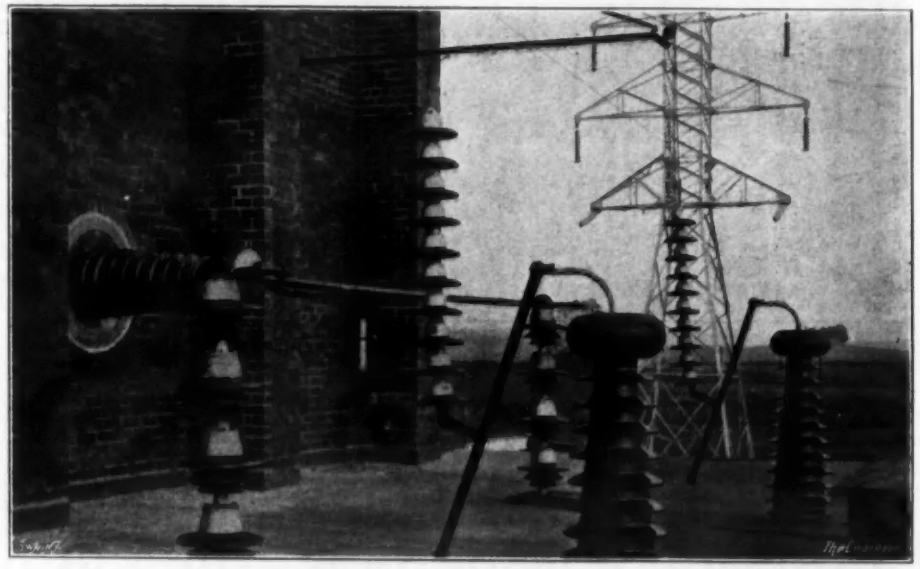

FIG. 13—ISOLATING SWITCHES ON ROOF OF FOG AND MACHINE ROOMS

FIG. 14—MECHANICAL RESEARCH LABORATORY

FIG. 15—MACHINE FOR TESTING INSULATORS UNDER VIBRATION

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THE ENGINEER.

VOL. CXLIX No. 3879

MAY 16, 1930.

Noise Problems in Electrical Machinery.

ALTHOUGH in some cases the noise emitted by electrical machines is of little or no importance, quiet operation is, nevertheless, often very essential. The noise of converting plant in sub-stations situated in residential districts has often proved a source of nuisance, but since the introduction of the mercury vapour rectifier one solution of the problem has been found. Not long ago we visited a sub-station in London where the converters had been completely enclosed in metal casings, in order to diminish the noise, which had previously given rise to serious complaints from people in the neighbourhood. Recent extensions to the plant have, however, been made with mercury vapour rectifiers and the trouble has been completely overcome. To deaden the sound of large converting plant is not always an easy task, especially if the building which contains the apparatus has not been constructed with that object in view. The reduction in the amount of noise made by electric motors and other machines is another problem with which engineers are sometimes faced. Even the hum of a transformer may prove objectionable in certain cases, although it is, as a rule, of little importance. When other noises are much greater than those created by a motor, as, for instance, those of a large engineering workshop, there is, of course, little object in employing a quiet electrical machine. But in other cases a noisy motor may prove highly objectionable and may seriously retard work that requires mental concentration. It is easy to think of conditions under which quiet running machinery is necessary, and it is not surprising that certain electrical manufacturers, notably the Metropolitan-Vickers Electrical Company, have devoted attention to the design of machines that work without noise.

The paper on "The Analysis and Measurement of the Noise Emitted by Machinery," read some time ago before the Institution of Electrical Engineers by two of that company's engineers, Messrs. B. A. G. Churcher and A. J. King, shows that the problem has been tackled on highly scientific lines. Within recent months papers on "Quiet Induction Motors" and "A Study of Noises in Electrical Apparatus" have also been read in America, where a need for silence is also being felt. From their investigations Messrs. Churcher and King have come to the conclusion that the key to the whole matter is the analysis of the complete sound wave emitted by the machine into its component frequencies and the identification of each frequency with some constructional feature of the machine. By measuring the sound pressure of each component as well as its frequency other valuable information can be obtained. It is possible to decide, for instance, which component contributes most of the noise and therefore which requires most attention. Having made an alteration in the design of the motor, the investigator can ascertain by a second set of measurements whether he is moving in the right direction, and by reference to some standard of loudness decide whether he has proceeded far enough. It is evident that the first step towards eliminating noise is to trace its cause, and in rotating machines this is made possible by the fact that in most cases each source of sound emits a characteristic frequency. The blades of a fan, for instance, as they pass some stationary object will set up pulsations in the air pressure of a frequency equal to the number of blades multipled by the revolutions per second of the fan. A fan with ten blades running at 1500 revolutions per minute will give a frequency of 250 cycles per second, a note almost equal to the "middle" C. Conversely, if it is shown that the frequency of a note when divided by the number of revolutions per second gives the number ten and there are ten blades on the fan, it is a reasonable conclusion that the note is caused by the fan. In a similar manner the components in the total sound pressure wave caused by the armature slots and by the commutator bars in a direct-current machine can be identified. With the methods and apparatus for obtaining a quantitative analysis of complex sound waves over a large range of frequency and pressure we shall not attempt to deal. Those who wish to go more deeply into the subject should refer to Messrs. Churcher and King's paper, which should prove a distinct help to engineers who are interested in the problem of reducing or eliminating noise emitted from machines. As the title implies, however, it deals with the analysis and measurement of noise rather than with the actual methods of making machines run quietly. But as a means of finding what parts of a machine should be attacked and of discovering whether the investigator is proceeding in the right direction, the authors' experiments are of the utmost value. The two American papers to which we have alluded throw rather more light on the question where the main noises in electrical machines come from. In the paper on "Study of Noises in Electrical Apparatus," by Messrs. T. Spooner and J. P. Foltz, published in the *Journal* of the American Institute of Electrical Engineers of March, 1929, one or two rather exceptional causes of noise are mentioned. Just as other engineering troubles occasionally prove perplexing, so may abnormal noise occasionally prove difficult to explain. By analysing the sound emitted by a motor or other machine, however, the source of each disturbance can usually be detected, so that the design can be modified until an approach to inaudibility is effected.

While the spade work in the production of quiet-running machines has been done, and while much knowledge of the subject has been gained, many problems remain to be solved. It is not reasonable to expect, for instance, a large machine to emit no more noise than a small machine or a high-speed machine to run as quietly as a low-speed one, and the influence of size and speed on noise is one of the subjects that still calls for investigation. The elimination or reduction of noise is a matter to which we have often drawn attention, especially in connection with road traffic. This branch of the subject, we are pleased to note, has not escaped the attention of Messrs. Churcher and King, who apparently contemplate applying their methods of analysis and measurements to motor vehicles and tramcars. To have devised ways and means of making electrical machines run more or less silently is certainly a notable achievement, but if the authors succeed in reducing the noise in the streets of London and other busy parts, they will have accomplished a task for which many besides users of electrical power will be thankful.

Radiant Heat in Boiler Furnaces.

THE experiments of Nicolson and the teachings of Perry laid such stress on the importance of gas velocity in promoting the transmission of heat to boilers that for a generation or more the still greater effect of direct radiation from the burning fuel was almost disregarded. Practical experience might have warned engineers that the equations of

Reynolds on which these teachings were based were not in themselves sufficient to account for the facts. Nothing in the theory could explain, for example, how it was that a much greater quantity of steam was produced per square foot of fire-box surface in a locomotive than was formed on an equal area of tube surface over which the gas velocity was many times higher. The shadow of scientific authority, however, lay heavy, and no doubt retarded a truer conception of the conditions. This perhaps did not matter much so long as the vast majority of boilers was internally fired. The relative proportions of the heat entering the water-cooled surfaces by radiation and contact transference respectively were of little more than academic interest, for even an exact knowledge could hardly have influenced design. But with the development of the water-tube boiler the question began to be of practical importance. The designers of such boilers not only had a far greater control of the gas velocities over the heating surface than in the case of Lancashire or Cornish boilers, but the principle of external firing allowed them at the same time to vary almost as they liked the proportion of the surface exposed to direct radiant heat. With increased rates of combustion, and particularly as a consequence of the use of pulverised coal, furnaces were built higher and higher, the lowermost row of boiler tubes being relegated in some cases to a height of 30ft. or more above the furnace bottom. The lofty walls, exposed to intense heat which they reverberated more to each other than to the distant boiler surface, naturally gave trouble. The obvious way to protect them was by extending the water circulating system of the boiler by means of water tubes down the furnace walls, thus turning the excessive radiant heat to useful purpose. Practice is, indeed, clearly tending to the total elimination of furnace brickwork, a result already achieved in the Wood boiler in which the furnace is completely enclosed by tubular heating surface.

The wheel thus appears to be turning full circle, and we are coming back to the conditions of the internally fired boiler. There is, however, one outstanding difference. The designer of the modern power station boiler with its water-cooled furnace can vary the shape and size of the latter, and can alter the proportion of boiler heating surface to furnace heating surface almost as he wishes. With the old tank boilers of the Lancashire and Scotch types, no such liberty was allowed. The freedom of design to which we have referred has brought into great prominence the part played by radiant heat in transmitting the energy of the incandescent fuel, and the flaming gases directly to the tube surfaces. During the past few years much attention has been given to this question, and even longer ago than that, "Nicolson and Callendar"—to quote the words of Mr. George Orrok—"have given us beautiful radiation formulæ, which cover pages of some of the English institutes, but when one attempts to work them out, he finds that he has to spend five hours calculating one special case, so, therefore, they are of no use to an engineer who is actually doing work." A similar criticism might be passed on the more recent and highly mathematical study of radiation by Dr. Schack, which has been brought to the notice of English engineers by the latest "Annual Memorandum" of Dr. Petrie, the chief engineer of the Manchester Steam Users' Association. It is true that some curves are given for the avoidance of tedious calculations, but as "to utilise these curves for the determination of luminous flame radiation . . . it is necessary to know the black-body temperature of the flame and its true temperature," the designer is not much further forward. He does not know the temperature at all, black-body or otherwise, nor does he feel safe in computing it on account of the as yet unknown effect of radiation. The work of Dr. Schack illustrates how great a gulf is fixed between the mind of the physicist, who is content to analyse an existing phenomenon, and that of the engineer who has to produce the sort of phenomenon he requires. It must not be forgotten, too, that there is something besides radiation going on in a water-cooled furnace. Heat is being transmitted to the tubes, also, according to the classical teaching, by conduction and convection. If we regard the distinction between conduction and convection as being meaningless, both consisting of a transference of heat by molecular contact, we still have two different modes of heat transmission taking place simultaneously. This, however, need not disturb the furnace designer. So long as a given quantity of heat gets into the tube the manner of its entry is immaterial to him. Nor need he concern himself, in the first place, with what the temperature of the furnace may be, for although it is the temperature which determines the heat absorbed by the water tubes, the temperature itself is dependent on the rate of combustion and the quantity of air admitted. We come down, therefore, to factors which can be readily handled by the designer, who, indeed, must make up his mind about them at the outset of his work. It now begins to be evident that some reasonably simple formula should be obtainable for the calculation of the heat absorbed by heating surface placed in boiler furnaces, at any rate with as much accuracy as the circumstances demand. Such a formula, due to Hudson, was first published in our columns just forty years ago. It was noticed by Mr. Orrok, who has shown that it is applicable to boilers differing as widely from one another as those of the locomotive and power station types. According to this formula, as modified by Mr. Orrok, the quantity of heat in B.Th.U. per hour entering every square foot of water-cooled surface exposed to radiant heat is given by the expression—

$$\text{C.H.}\left(\frac{1}{1+\frac{\text{A}\sqrt{\text{C}}}{27}}\right)$$

in which C is the number of pounds of coal burnt per square foot of heat-absorbing surface per hour, H is the calorific value of the coal, and A is the number of pounds of air per pound of coal. Figures calculated from this expression have also been shown to compare very well with those deduced from the extremely elaborate computations of Professor Wohlenberg, the principal American investigator of practical problems in radiant heat.

The Hudson-Orrok formula is purely empirical, and time may show that a greater accuracy may be obtained by some different expression. It is, however, so convenient, in comparison with anything yet put forward by the physicists, that its reproduction seems well worth while. As Mr. Orrok has pointed out, it permits an engineer to separate the work done by the furnace tubes from that done by the boiler proper in an actual test, and so to determine the proportion of the total heat absorbed by convection in the boiler. It is perhaps even more useful, when a new design is being got out, in permitting a close estimate of the effect of any heat-absorbing surface exposed directly to the furnace flames. The fact that the formula has only an empirical foundation is not to be adduced against it. No knowledge is so certain as empirical knowledge, for it is the science of experience. Its danger lies in using it as a guide too far beyond the limits of experience. As these extend, so is opportunity afforded for revision of empirical formulations, so that they may still serve us well until they can be replaced by equally manageable expressions founded on established laws of Nature. The time when this can be done in respect of the abstraction of heat by tubes in a boiler furnace is probably distant.

The Royal Society's Conversazione.

THE exhibits displayed for the entertainment and instruction of the guests at the Royal Society's conversazione, held at Burlington House on Wednesday evening, were fewer in number than usual, and included less than the customary percentage having a direct or indirect engineering interest. The engineer is, however, or should be, catholic in his scientific tastes. Professor D. M. S. Watson's lecture on the flight of pterodactyls provided an object lesson in the desirability of cultivating one's acquaintanceship with departments of scientific investigation outside one's professional field. It would appear that when Captain Hill named his tailless aeroplane the "Pterodactyl" he was not indulging, as it might seem, in an unjustified flight of terminological fancy. At any rate, Professor Watson has been studying how the extinct reptiles which we call pterodactyls were enabled to fly. He has discovered that they were as perfectly adapted for flight as any living bird of to-day. In their structure they carried weight saving to an extreme degree, and in the articulation of their bones they exhibited the perfection of machinery. Professor Watson has found it possible to establish the nature of the movements which their wings could perform and, applying modern aerodynamical knowledge to the problem, has deduced therefrom a knowledge of the creatures' mode of life. The type of flight which they possessed may, Professor Watson suggests, offer a hint for the improvement of aeroplane design.

Of less obvious application as illustrations of our moral, but none the less of intense interest to the scientifically minded visitor, were the photographs of the new planet which the Radcliffe Observatory of Oxford exhibited. The reader will not suppose that what was shown was anything in the nature of a portrait of the newly discovered member of the solar system, a portrait such as that of the moon or the corona of the sun during an eclipse with which we are familiar. Two glass negative transparencies made by means of a 24in. Grubb refractor with an exposure of an hour each were shown side by side. One was made on March 29th and the other on April 2nd this year. Each plate showed a large number of blurred points of light—about 200 we should suppose—of various sizes and each representing a star. Of all these stars only one would be visible to the naked eye. It was the largest one on the plates and its image had a size equal to that of a smallish pea or thereabouts. The astronomers call it 3 Geminorum and assign to it a magnitude of 3·5. The new planet has a magnitude of 15 and appeared on the plate as a speck of light about as big as the point of a blunt pencil. If the two plates had been superimposed it would have been found that the points of light on the one would have coincided with those on the other, each with each, except in the case of the new planet. The movement which it executed during the four days between the two exposures resulted in its being displaced on the second plate by about ¼in. from its position on the first. Hence arises its claim to being a planet and not a star. Now that it has been discovered the wonder is that the dignity which is its due was not accorded to it long ago.

An early Italian terrestrial globe and some maps exhibited by Mr. R. S. Whipple interested us because of an apparent contradiction which we detected in them. They dated their origin to the years 1555–1560. On the one hand, they showed a surprising amount of knowledge concerning the geography of Europe, Africa, Asia, and the two Americas—even going so far as to indicate the origin of the Nile in the lakes which the discoveries of last century proved to lie at its source. On the other hand, the river Amazon was shown as rising somewhere in the south of Patagonia and flowing north for almost the whole length of South America until it turned westwards, and after a relatively short distance debouched into the Atlantic. Yet twenty years before the globe was engraved or the maps drawn, namely, between 1540 and 1542, Gonzalo Pizarro had climbed the Andes from Quito and had found the headwaters of the Amazon, and his lieutenant, Orellana, constructing a brigantine, had sailed down the river and crossed the Atlantic to his native Spain. Here is an illustration of the slowness with which the knowledge of discovery spread four centuries ago. It may be contrasted with the corresponding speed to-day, as exemplified by the rapidity with which news of the new planet and confirmation of its existence passed from the New to the Old World.

Mr. L. S. B. Leakey came as near as any exhibitor did to showing a machine of direct engineering interest, although his appliance was far from having its origin in anything connected with our profession. Those who, like Sir Arthur Keith, study the formation of modern and ancient skulls are troubled by the fact that photographs give a distorted representation of their shape. A drawing by a skilled artist is found to be superior in accuracy to a photograph, but even a drawing so prepared cannot be relied upon to be correct to more than a millimetre and then only after the expenditure of much time on it. Mr. Leakey set about devising a machine which would improve the accuracy of the representation and economise the time spent on preparing it. With the assistance of the Cambridge Instrument Company he eventually produced a machine comprising a telescope with cross wires, a horizontal table carrying a sheet of drawing paper and a pair of hand-operated screws at right angles, whereby a pencil pressing on the paper could be moved simultaneously and in exact proportion with the movement of the telescope up or down or crosswise. The telescope is focussed on the skull and by means of the screws—and after some skill has been acquired by practice—the cross wires are made to follow its outline, the form of the eye sockets, the shape of the teeth, the course of the sutures and so forth. As the telescope is moved the pencil follows an exactly proportional path and draws on the paper a picture of the skull. By an arrangement of two mirrors at 45 deg., one above and one below the skull, three drawings, one an elevation, as an engineer would call it, another a plan view from above, and another a plan view from below, can be obtained without moving the skull. The use of the apparatus has been extended to the accurate representation of fossils, pottery, palæolithic instruments, &c. It is not difficult to imagine circumstances in which the machine might be of great value to engineers. It is claimed to be capable of giving a drawing of the object before it accurate to a fifth of a millimetre.

The exhibits of the National Physical Laboratory were chiefly illustrative of work carried out for the Radio Research Board. We were particularly interested, however, in another of the Laboratory's exhibits, an instrument or equipment for measuring the friction and wear-resisting properties of jewels, such as those used in the construction of watches, electrical meters and scientific measuring instruments of various kinds. The jewel to be tested was mounted at the centre of a small disc of known weight and moment of inertia, and so placed was used to support the disc on the end of a hardened vertical steel pivot

or spindle which could be rotated at a hundred revolutions a minute. A compass needle fixed on top of the disc in conjunction with the earth's field or an artificially applied field maintained the disc and jewel stationary against the frictional turning moment applied by the spindle. The amount of wear which occurred in a given period was determined by noting the rise in the coefficient of friction between the spindle and the jewel. This coefficient was measured by removing the compass needle so as to set the disc free to rotate under the frictional driving force. From the speed of rotation of the disc as thus set free and the knowledge of its weight and moment of inertia the coefficient of friction could be calculated in standard terms. The equipment was provided with eight discs and spindles, in order that eight tests might be carried out simultaneously. We were very interested to learn that difficulty was sometimes encountered as a result of the spindles rusting at their points of contact with the jewels. The Laboratory authorities are satisfied that the rusting is not caused by moisture in the air and that it is another manifestation of the phenomenon known as the mechanical production of rust.

The extent to which science is being applied to improve the construction of our homes was illustrated by a micro-volt-hour meter shown by the Building Research Station. This appliance was devised for investigating the flow of heat through windows. It is so constructed that a flow of one British thermal unit per square foot per hour produces an electromotive force in the instrument of 70 microvolts. An addition to the equipment enables the total heat flow over any given period to be integrated and recorded on a counter.

Sir Robert Hadfield exhibited a number of specimens illustrating some special properties and applications of ferrous alloys. One of his exhibits had a deep antiquarian and philosophical interest. It was a specimen of iron excavated from the base of the Khan Baba column in the Indian State of Gwalior. This column dates from about 30 B.C. On analysis the iron was found to contain 0·70 per cent. of carbon, and on quenching it in water from 830 deg. Cent. it acquired sufficient hardness to scratch glass, the Brinell figure being 652. This specimen, therefore, after being in existence for over 1900 years, behaved in exactly the same manner as modern carbon steel. It showed, as Sir Robert remarked, that no time effect wipes out the remarkable property possessed by steel of hardening by quenching, a phenomenon which still cannot be explained completely and satisfactorily.

Canadian National Research Laboratories.

A HISTORIC incident in the development of scientific research in Canada occurred at the end of 1929 when the Federal Government made a contract for the construction, at a cost of nearly 3,000,000 dollars, of a National Research Laboratories building at Ottawa. When fully equipped this building will place at the disposal of Canadian industry, research facilities for its development among the finest to be found in any country. Its completion will be the realisation of a dream long cherished by those who saw that such an institution must be provided if Canadians were to become a virile and self-reliant people. The site of the building is on the banks of the Ottawa River, near the confluence of the Rideau, and the historic residence of Sir John A. Macdonald, the Dominion's first premier.

Faced with Wallace sandstone that is to be brought from Nova Scotia, the building—a photograph of a model of which is reproduced in the accompanying engraving—will stand 60ft. high, be 418ft. long and 176ft. deep. Into the plans for the building and equipment has gone knowledge gained from all the advanced scientific countries of the world. Officers of the National Research Council have personally inspected the research institutions of Great Britain, Germany, Japan, France, and the United States. Built in the form of a squared figure "8," the building will have two inner courts. Eventually they will be used for research museums and exhibition halls. In the section of the building running from front to rear between the courts will be housed a scientific research library and an assembly hall, designed to accommodate 300 persons. Associated with the library will be the Council's Division of Research. Space will be available in the building for various departmental laboratories of the Government. One such laboratory to be housed in the new building will be that of the gas and electricity inspection service of the Department of Trade and Commerce.

Almost the entire rear portion of both the basement and first floors will be occupied by the engineering physics laboratories. There the high-capacity testing machines and cranes that made a high ceiling necessary will be arranged. The cranes in the hydraulic and thermo-dynamic laboratories will be of 10 or 15 tons capacity. In the electric laboratories will be apparatus capable of testing up to 500,000 or 600,000 volts.

In the north-west end of the building will be various branches of the Division of Pure and Applied Physics. In the south-west will be departments devoted to the activities of the Division of Pure and Applied Chemistry, and on the top floor the Division of Economic Biology and Agriculture will be provided for. Arrangements are being made to accommodate the Division of Industrial Engineering, the Division of Textiles, the Division of Standards and the other divisions as required for the improvement of industrial processes, the development of natural resources and the utilisation of waste.

Plans for the building aim at making the organisation combine the functions of the National Physical Laboratory of Great Britain, the Bureau of Standards at Washington, and the Mellon Institute at Pittsburg, which devotes its entire energy to the carrying on of research by private firms at their expense.

Temporary laboratories now being equipped at Ottawa embrace ten rooms in the Division of Pure and Applied Chemistry and will enable a start to be made on a number of research projects pending the time when the permanent laboratories have been built and equipped. The wing in the latter building, which will be devoted to the Division of Pure and Applied Chemistry, will comprise more than fifty rooms equipped with fittings and apparatus of the most up-to-date type, and will provide facilities for research work in all important branches of chemistry.

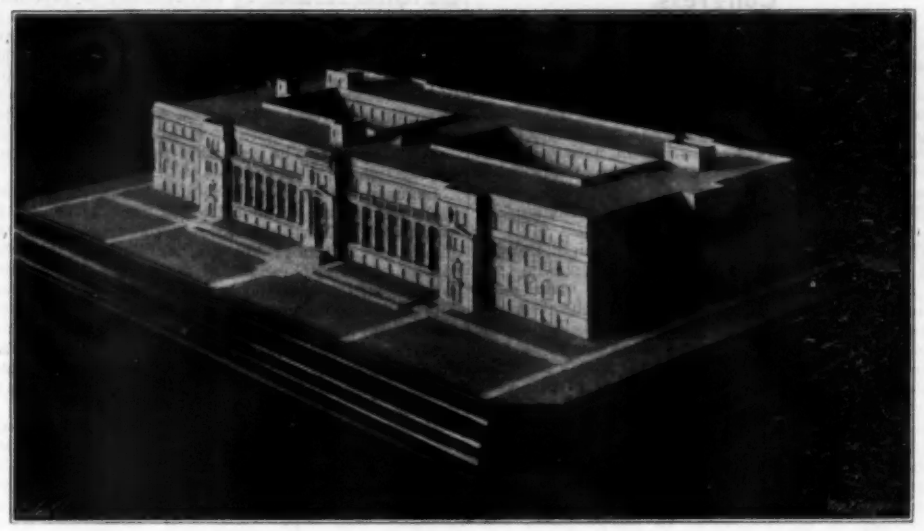
The National Research Council is also giving special attention to aeronautical research. In buildings that might almost have been constructed originally for that very purpose, but which, before their purchase some time ago by the Dominion Government housed a lumber mill, work is now well advanced on:

(1) A wind tunnel for aero-dynamic research and testing, 9ft. in diameter, through which a 13ft. propeller will deliver air at a speed of over 125 miles an hour.

(2) A towing tank 400ft. long, 8ft. wide and 6ft. deep for the testing of aeroplane floats, hulls and other high-speed craft.

(3) Complete engine-testing plant, capable of accommodating aircraft engines of any type and of absorbing powers up to 1000 horse-power at speeds up to 2500 revolutions per minute.

MODEL OF CANADIAN RESEARCH LABORATORIES BUILDING



Books of Reference.

Directory of Paper Makers of Great Britain and Ireland for 1930. London: Marchant Singer and Co., 47, St. Mary Axe, E.C. 3. Price 5s.—As the present volume is the 54th annual issue of this publication, it is so well known that all we need say is that all the usual features have been retained, and that, evidently, the book will be found to be just as useful as previous issues have been.

The "Automobile Engineer" Reference Book. London: Iliffe and Sons, Ltd., Dorset House, Tudor-street, E.C. 4. Price 7s. 6d. net.—The present edition—the 2nd—of this book of reference constitutes a complete revision of all the standard reference tables and also embodies many new sections. It is divided into seven parts. The first deals with the properties of numbers and gives tables of circles, area and circumference, square, cubes, logs, &c. The second treats of weights and measures and contains some useful conversion factors. Mechanical data are considered in the third, while engine performance and design form the subjects of the fourth. In the fifth chassis design is discussed, while the sixth is concerned with "Fuels: Physical and Experimental Data." In the seventh section there are English-French and French-English dictionaries of technical terms, especially those likely to be of use to users of motor cars. We note that the horse-power Treasury Rating Tables have been expanded to include eight-cylinder engines. They have been completely recalculated from 50 mm. to 150 mm. by 1 mm., and from 2in. to 6in., rising by ¼in. There are also articles dealing with supercharging, piston clearances, modulus of fly-wheels, gear-boxes, back and front axles, steering gear, brakes and laminated springs. We may add that the information given in the book has been compiled by the Editorial Staff of "The Automobile Engineer."

Sell's Directory of Registered Telegraphic Addresses for the Year 1930. Published by Business Directories, Ltd., 8 and 9, Johnson's-court, Fleet-street, London, E.C. 4. Price 45s.—It would be difficult to speak too highly of this invaluable book of reference, which, by the way, has been described as "a library in itself." One has only to be without it for a few days, as we have, unfortunately, been during the course of the preparations for our removal to larger offices, to realise how often we have to consult it and how much we rely on it. As is now well known, not only does it contain a complete and authentic list of telegraphic addresses, but telephone numbers are also given, and there is an extensive list of classified trades with three thousand distinctive trade headings. Other useful features are (*a*) a list of newspapers and periodicals, with their place of publication and charges for space; (*b*) a list of members of the London and Provincial Stock Exchanges; (*c*) an American Section for the benefit of those desiring to trade with the United States, and (*d*) a section giving information as to the principal exporters in the Dominions and in several foreign countries. The publishers say that if they were "to claim that this book exercises a lubricative influence on the wheels of trade" they would "be on safe ground," and we think that they would be.

B.E.S.A. SPECIFICATIONS.

STRUCTURAL STEEL FOR BRIDGES AND GENERAL BUILDING CONSTRUCTION.

THE new revised edition of the British Standard Specification for Structural Steel for Bridges and General Building Construction, B.S.S. No. 15–1930, has just been issued by the British Engineering Standards Association. The first edition of this Specification appeared in 1906 and it was revised in 1912. In the present revision a number of modifications have been made, of which the principal are the following:—

(i.) All reference to the basic Bessemer process is now omitted.

(ii.) Drawn steel wire from 0·5in. to 0·125in. in diameter, which has subsequently been suitably heat-treated to enable it to conform with the requirements of this Specification, is now included. Hard drawn steel wire for concrete reinforcement, not so treated, is dealt with under Specification No. 165.

(iii.) A tensile test in addition to a bend test is required for bars for concrete reinforcement.

(iv.) Temper bend tests are not now specified.

(v.) The radius of the bend in the cold bend test has been made smaller for bars of 1in. diameter and under.

(vi.) Tolerances on the specified depth of beams and channels have been inserted.

Copies of this Specification may be obtained from the British Engineering Standards Association, Publications Department, 28, Victoria-street, S.W. 1, price 2s. 2d., post free.

A HOME OFFICE circular has been issued stating that the Home Secretary's attention has been drawn to the risk of injury to workers employed in the processes of electrolytic chrome plating and anodic oxidation, which have recently been introduced. As the result of a medical inspection of 200 workers engaged in these processes, the Home Secretary has certified the processes to be dangerous, and he proposes to make regulations requiring exhaust ventilation, provision of protective clothing, washing facilities, periodic inspections of the hands and forearms, and periodic medical examination by the certifying surgeon or by a doctor appointed for the purpose, who is empowered to suspend workers from employment in processes involving contact with the liquids. Copies of the draft regulations may be obtained on application to the Factory Department, Home Office, London, S.W. 1, and any objection must be sent to the Home Secretary within forty days.

The International Railway Congress.

No. IV.*

SUBJECT VIII.—ALL-STEEL COACHES: COMPARISON WITH VEHICLES BUILT OF WOOD.

FOUR reports upon this subject are presented. Report No. 1, for Belgium, France, and the French Colonies, is jointly by Mr. Lancrenon, assistant chief mechanical engineer of the Northern Railway of France, and Mr. Vallancien, principal engineer at l'Office Central d'Etudes de Matériel de Chemins de fer, Paris.

These reporters remark that the principal Belgian and French railways are unanimous in agreeing that all future rolling stock should be of metal construction. That view is mainly due to the desire to increase safety. A pamphlet, which was issued for publicity purposes by rolling stock builders and circulated a few years ago to all the railway administrations, showed in the form of photographs a very impressive comparison between the results of accidents which had occurred in various parts of the world with trains composed of wooden or metal rolling stock. Although that publication was no doubt biased, it was clear that, both from the point of view of resistance to impact and as regards the risk of fire, considerations of safety sufficed to justify metal construction.

Those are not the only reasons. The substitution of riveted or welded joints in place of wooden joints give the bodies a rigidity which conduces to the comfort of passengers. Metal construction also lends itself to the use of interchangeable standardised parts, and if certain of the processes of flanging and welding require specialist operators, it is possible, on the other hand, to dispense with the costly labour of coach builders and cabinet makers.

The reporters say that it is not yet possible to give exact information of the probable life of such vehicles, but it is clear that, provided running repairs are carefully attended to, it will be possible to increase appreciably the period between the costly general repairs required by wooden vehicles. They add that contrary information has been received as to hot countries. It appears, however, that the metal vehicles are better able to withstand decay set up by warm and damp climates, and the effect of animal parasites. Provided good measures of heat insulation are used, the stock should be as comfortable as the existing coaches.

The investigations of the great French railways for the last ten years have rather tended towards the principle of a metal girder in which all parts of the vehicle contribute to the strength of the whole. That method allows the weight of the stock to be reduced, seeing that the framing of the body strengthens the girder, and the weight of the underframe may therefore be reduced considerably. In case of the telescoping of two vehicles as the result of a collision, one can reckon on escaping the disastrous effects which result from the underframe of one vehicle penetrating the next vehicle.

The report then asks the question, Are these advantages sufficient to offset the considerable increase in tare weight per seat? The reporters answer that they do not think so. Their opinion is that "as the design of metal coaches is still a new departure in France, we shall in the near future be able to build metal stock which will compare favourably from the point of view of weight with wooden coaches."

The metal coaches already in service have given every satisfaction. Their stability at high speed has proved to be superior to that of wooden stock, because of the greater height of the centre of gravity and the corresponding lengthening of the amplitude of oscillation. In view of the precautions taken in their construction, they have been found to run very quietly and to be little affected by variations in the external temperature. The additional safety obtained may be considered as having been achieved without incurring excessive cost.

All countries except America, the British Empire, China, Japan, Belgium, France and the French Colonies are covered by Report No. 2, for which Mr. Martin Garcia-Vara, engineer of the Andalusian Railway and Mr. Pablo Fraile, assistant to the rolling stock controller of the Northern of Spain, are responsible. It is a short, but, considering the minor countries it covers, very instructive report.

Metal rolling stock, the reporters observe, can be considered under three different aspects:—(1) Safety of the passenger; (2) strength and durability; (3) economy in maintenance. The whole of the railways are, in relation to (1), in agreement that steel stock should be used, because the great strength of metal bodies makes telescoping less likely. The splintering of the woodwork does not occur, and, finally, there is no danger of fire.

It is not possible to give any information as to (2). Logically, the life of metal coaches should not be greater than that of wooden coaches, and nothing has occurred to justify any contrary opinion. For the same reason it has not been possible to obtain any accurate information in respect of (3). There is no doubt, however, that the rigid connection of the various parts of the metal body will show a definite advantage over the assembly of the same details in wooden bodies, the troubles with which are being still further increased by the difficulty of procuring wood of proper dryness and seasoning. In spite of their small experience, several railways which have used metal coaches for the last five years are satisfied that they have shown a saving in the cost of repairs. It is considered too early to form an opinion as to corrosion. Several companies speak of a possible reduction in the weight of metal coaches, but that does not appear to be generally proved when comparing the two types of vehicles.

In general, the various administrations tend towards the construction of metal stock, but some of the companies in Northern Europe, when balancing the advantages and disadvantages, wonder if it is desirable to adopt steel coaches for their countries. The Finnish Administration is of the opinion that the very severe climate there during the winter would result in greater cold in the trains. It further is afraid that moisture would condense on the inside of the coaches, and that the metal vehicles are heavier and more costly. Most of the administrations covered by the present report share the last opinion.

Report No. 4, for America, the British Empire, China, and Japan, is by Mr. E. J. H. Lemon, of the London, Midland and Scottish Railway. It is a very long document, but that is mainly due to 50 pages out of the total of 126 being devoted to the replies received from the thirty-four companies which answered the reporter's questions; twenty-four of the eighty-seven administrations written to said that they had no all-steel carriages; whilst twenty-nine had not replied when the report was prepared. In view of the length of the report, we propose to cover British practice only.

The Great Western has only one experimental all-steel coach. It was found to be considerably heavier and more costly than the standard vehicle. The London, Midland and Scottish, in addition to 141 vehicles used in electrically operated trains, has 235 vestibule carriages and 200 passenger brake vans. A further 100—whether carriages or brakes or both is not stated—has recently been added. The London and North-Eastern built three kitchen cars in 1914 and has 119 all-steel carriages in service. The Southern has no all-steel passenger stock.

The all-steel vehicles recently placed in main line service on the London, Midland and Scottish have the body and underframe combined to form a long tubular girder, of which the top member is the roof and the bottom member is formed by the underframe. The sides are kept as free as possible of doors in such positions as would weaken the structure. The main body framing is composed of pressings and steel sections; the body side and end panelling consists of mild steel plates, charcoal-finished, lead-coated, 0·09375in. thick; for the roof there are similar plates, 0·080in. thick, galvanised. A special rolled section forms the rain gutter, which acts partly as a cant rail and connects the body and roof together, as well as supporting the carlines to which the roof plates are attached.

The kitchen cars of the London and North-Eastern are built on a trussed underframe made of standard rolled sections, with the body of charcoal-finished, cold-rolled, hydraulically flattened panel plates. The roof exterior is covered with mild steel plates, with cotton duck as an outer covering. The underframes of the open thirds—we presume the vestibule third-class coaches—are not trussed and the main body framing is composed of a series of complete ribs, formed by the pillars and carlines, with longitudinal members at the waist, cornice and roof, the whole being covered with steel sheeting.

Very full details are given of the methods of construction adopted by the various companies, but we can deal only with an item that is of general interest, *i.e.*, the attachment of the panels to the main body. On that point Mr. Lemon reports that in Great Britain both snap and countersunk rivets have been used; the latter, being flush-headed, give a more pleasing appearance to the outside of the carriage and the exterior can also be more easily kept clean. Doubt has been expressed as to the efficacy of using countersunk rivets, as it is thought that, if thin plates were joined together, the joints so formed would not stand the vibration and that the rivets would work loose. If, however, proper attention is paid to the workmanship no difficulty should be experienced in such an arrangement. The important information is added that experience with carriages concerned in collisions has proved that this method of riveting is satisfactory.

Vitreous enamelled steel panelling is used on the London, Midland and Scottish. It is drilled and placed in position before enamelling. A special design of snap-headed rivet, with a hollow shank, is used to allow for any stretching of the plates after enamelling.

Owing to the quicker heat transference in all-steel coaches, as compared with wood, heat losses are bound to occur unless steps are taken to insulate with asbestos or other type of blanket. Whilst certain railways in Africa, Australasia and India have stated that they have no problems on that point to meet, China, the United States and other railways in Africa, Canada and India report the adoption of insulation. In the Argentine it is the practice to use cellular waterproof asbestos, whilst in China felt and asbestos paper are used. A further precaution taken in the latter country is to fit a false floor of sheet metal with a compound board inserted.

On the London, Midland and Scottish some of the carriages have a pocket between the steel plates and interior finishing, which is sealed up. An insulating material is attached to the plates on the inside and secured to the panels by bitumastic solution or cement, and, in some cases, narrow steel binding strips are added. In other carriages a free air space is arranged between the outer steel panels and the interior finishing.

Coming to the question of maintenance, the report says:—"The relative maintenance costs of carriages of all-steel and of wood, provided the vehicles are given proper attention, should be about equal, which, as far as life is concerned, may be considered to become obsolete before they are worn out. Various reasons have been advanced to show that maintenance costs should be lower for steel carriages than for wood."

We notice, among the companies which report favourably on this point, that the Wabash, U.S.A., states that, taking the costs over a ten-year period, the average yearly expenditure per coach is:—For steel, 983 dollars; and for wood, 1212 dollars, a saving of 19 per cent. in favour of steel.

A significant statement is then made by Mr. Lemon. He remarks that carriage maintenance costs can be split up into eight heads: (1) body; (2) underframe, including wheels, axle-boxes, buffing draw-gear, &c.; (3) interior, upholstery, decorative panelling, &c.; (4) lighting; (5) heating; (6) braking; (7) lavatory fittings; (8) painting. He then adds:—"It is suggested that the only savings on purely maintenance costs, which could be obtained from the steel carriage, as compared with the wooden, are in the repairs to the body and in painting."

After a reference to the anti-telescoping device introduced on the Great Central by Mr. J. G. Robinson and to the articulated arrangement of Mr. Gresley, the report observes that the behaviour of steel carriages, in collision, shows that the end platforms and vestibules of the open type form a natural buffer and "yield point," accepting, at any rate, the first energy of the collision by crumpling up the vestibules.

Noise is another subject on which Mr. Lemon's opinion calls for special mention. He says:—"Provided a carriage is blanketed, similar to what is done in American practice, there should be little, if any, additional noise to that experienced in wooden stock. In the latter there is generally a certain noise due to creaking of the wooden joints, but in the steel carriage, owing to it being riveted up, the number of joints is reduced."

The opinion is freely expressed by the administrations concerned that there is necessity for further research in the following directions:—(*a*) Reduction in first cost; (*b*) reduction in maintenance cost; (*c*) reduction in tare weight; (*d*) use of special alloys for underframe construction and interior furnishings, and in the development of suitable materials to resist oxidisation; (*e*) necessity for a good system of insulation and for the prevention of noise; (*f*) substitute for the increasing cost of timber.

The report ends with five conclusions, which are as follows:—

(1) The substitution of steel carriages for those built of wood will continue. In the United States the building of wooden coaches has practically ceased. In Great Britain the tendency is to turn to steel carriages, because (*a*) they are much safer in case of accident and, weight for weight, have a much greater stiffness and strength; (*b*) steel, being a manufactured product, there is no likelihood of a shortage of supplies, with a consequent increase in price; (*c*) steel is manufactured in Great Britain and the raw materials used in the manufacture of steel are carried by the railways and, to that extent, increase the revenue of the railway companies; (*d*) there should be a reduction in maintenance costs, provided the tendency to corrosion of thin sheets can be satisfactorily overcome.

(2) First costs of steel carriages are gradually decreasing. Costs of painting are likely to be less as there is not the same tendency for paint to shell off as is the case when timber, which may be insufficiently seasoned, is used.

(3) The production of steel carriages, which will reduce the risk of injury to passengers, is a point to influence the travelling public in favour of railway travel.

(4) It is possible to produce a steel carriage, with wood interior finish, which will eliminate many difficulties now experienced in the way of oxidisation, noise, condensation—provided proper precautions are taken to thoroughly protect metal surfaces—reduce number of parts to a minimum, insulate adequately, and keep in a good state of repair.

(5) That a metal interior finish is not advisable in those countries having humid conditions and, where steel is used for underframes and body portions, special steps should be taken to use protective material and to give regular attention in that respect.

Report No. 4, for Germany, is by Mr. E. Dähnick, of the German State Railways Company, who says that the first steel coach for express trains in Germany was put into service in 1912. Apart from a few unavoidable defects, it proved to be satisfactory, and it was decided to revolutionise completely the design of German passenger coaches and to change over to the all-steel type of construction. Only the roofs were to continue to be made of wood, and that exception was due to the fear of excessive noise. In 1927 the change was extended to the roofs. The report says:—

The internal fittings of these all-steel coaches are, up to date, usually made of wood, both for decorative reasons and out of regard to the comfort of the traveller. Certain special designs were carried out for trial with steel partitions and without wooden fittings. One coach was also fitted up with interior furnishings made of a wood substitute. The tests of this new material have not yet been completed. They are, however, to be carried through as, in view of the great difference in summer and winter temperatures, it is hoped that the adoption of this material for interior fittings will offer considerable advantage to the passenger.

* No. III. appeared May 9th.

Under the heading of Results in Service, it is remarked that—

The maintenance costs of steel coaches must be less than with the wooden ones. Whilst it is possible that in the event of slight damage the cost of repairs to the steel coach will be higher because it may be difficult to replace some particular part of the structure in the bogie, body, frame or panelling, there is no question that the ordinary wear and tear in normal working will require substantially less maintenance in the case of the steel coaches.

SECTION III.

SUBJECT X.—MARSHALLING YARDS.

This subject is one of particular interest to British railway officers and those who follow British practices, in view of the car retarders installed by the London and North-Eastern Railway at Whitemoor and of what is offered as a simple arrangement—a slipper method somewhat on the lines of the Delrison system described in THE ENGINEER of February 7th last. There are four reports on the subject, which cover such items as gravitational and flat shunting, wagon brakes, &c., but we will confine our attention to the question of retardation only

Report No. 1 is for all countries except America, the British Empire, China, Japan, France, Italy, Portugal, Spain, and their colonies. It is by Mr. Ctibor Fiala, principal counsellor to the Czecho-slovakian Railways.

There is a Thyssen-Hütte hydraulic brake in the marshalling yard at Aarhus, in Denmark, and one at Susteren on the Dutch Railways. Slipper brakes of the Büssing type are also to be found at Aarhus; and at Romanshorn and Bellinzona in Switzerland, together with several places in Poland, particularly at Poznan.

Mr. Fiala observes as to the slipper type of brake that—

Some railways consider the ordinary slipper brake as a suitable method for regulating the speed of vehicles when shunted. This point of view can only be shared—and even then with every reserve—for cases where the shunting sidings are on a sufficiently steep gradient to ensure that a vehicle, once it has run on to a slipper, will continue to run, after the slipper has been withdrawn, by its own weight at a moderate speed and with a very slight acceleration. The ultimate speed of the vehicle is determined, to a certain degree, by the spot where the slipper was placed.

It is, however, remarked that slipper brakes are not as reliable as rail brakes, and the braking cannot be so nicely adapted to suit the distance to be covered by the wagons. Experience in Holland shows that, for the rail brake, the maintenance charges are somewhat high, as the wear is considerable and radical renewals are required every two years.

Among the conclusions of this reporter is the opinion that "rail brakes give better results than slipper brakes. They work more exactly and allow a better regulation of the speed of vehicles, and thereby so much the better ensure that the vehicles are stopped in the desired length. The vehicles suffer little damage and accidents are eliminated. Slipper brakes are, however, much simpler and cheaper."

Report No. 2, applicable to America, the British Empire, China, and Japan, is by Mr. C. R. Byrom, the chief general superintendent, London, Midland and Scottish Railway, who, in his opening remarks, observes that there are no marshalling yards in Great Britain equipped with rail brakes or shoe brakes. —slippers—operated mechanically, with the exception of one yard which, up to the time of reporting, had not been formally opened.

The Great Western uses what we hereafter refer to as slippers in the hump sidings at Bristol East depôt, when a wagon is running off the hump at a speed which is likely to cause damage to it or to other wagons or their contents. That company reports that the slippers are effective on dry rails, but on wet or slippery rails they are inclined to slide with the wheels before pulling the wagon up. With a cut of, say, four wagons, consisting of three heavy loads and an empty or lightly loaded wagon leading, the slipper is not as effective. The important information is added that even minor injuries reported are negligible, but the men have to exercise great care.

A description of what was intended to be done at Whitemoor follows, and it is remarked that the experimental working which had taken place and which was being continued promised success. It is, however, remarked that "one feature of interest revealed is that a small percentage of British rolling stock is fitted with wheels which have certain projections beyond the face, such as bolt heads and nuts securing the tire which would foul the rail brake if applied when passing through and be sheared off. These wagon wheels will, no doubt, be suitably converted in time, and in the meanwhile special provision will be made at Whitemoor to deal with them independently of the rail brake apparatus."

Some useful information is given as to American practice, but considering that the four-wheeled wagon in this country requires altogether different treatment from that needed by the heavy American car, no reasonable comparison can be made. For instance, in one yard in the United States twenty-five car riders or brakesmen per shift are required to deal with from 3000 to 3500 freight cars per day, but only twelve brakesmen per shift are necessary at Chaddesden, near Derby, to control 4000 wagons daily.

Among the reporter's conclusions, it is remarked that—

Where the amount of traffic normally dealt with is sufficient to justify the cost of installation, car-retarding, or rail-braking, methods appear preferable to any form of slipper, whether operated by power or manually, by reason of the much greater degree of brake power which can be applied. Power-operated slippers may be found to be desirable in some but not in all instances, as a supplementary or emergency measure where high-capacity cars or wagons are in general use, depending, to some extent, on the number of retarders fixed in series. Manually operated slippers are only advantageous in certain conditions, *e.g.*, where wagons or cars are not fitted with hand-brake or when necessary to supplement hand-braking, or where there is considerable variation in length of run through point or switching area in one portion of a hump yard as compared with another portion.

The authors of Report No. 3—for France, Italy, Portugal, Spain, and their colonies—are Messrs. Pellarin, of the Est Railway of France, and Farenc, of the Midi Railway, both of whom are operating officers. Their opinion of each of the two types of retarders—slippers and rail brakes—is that the low first cost of the slipper brake and that it is proportional to the weight of the wagon should be noted. The rail brake can be moderated and can be used for a rake of wagons, but it costs more. An important feature is brought out thus:—

It has been held against the slipper that it is violent in action and gives the vehicles running on to it a shock harmful both to the vehicle and to the load. That idea should, however, be corrected. The excess of shock due to running on to the slipper is negligible, seeing that the variation of speed of the wagons at the moment of meeting the slipper is too small to matter, owing to the relatively small weight of the slipper to that of the wagon. As regards the effect upon the axle by stopping it, it is the same as when the wheels are picked up by the continuous hand brake. That has never been considered, except for tire wear, as having any drawback.

Dr. Mg. Gottschalk, of the German State Railway Company, is responsible for Report No. 4, which applies to Germany alone, and possibly for that reason is the most interesting report of the four.

The German State Railway Company has, in addition to a number of small marshalling yards, sixty-six that deal with from 2000 to 3000 wagons daily, twenty-five that handle from 3000 to 4000, and twenty-seven with over 4000. Of these 118 yards, 113 are flat or non-gravitational; three are gravitational, and two are mixed. Of the 113 flat yards, fifty-two are single-ended and sixty-one are double-ended, *i.e.*, entered from either end.

After an interesting discussion on gravitational and hump shunting, Dr. Gottschalk considers the question of retarders and expresses the opinion that there should be two sets of brakes, so as to equalise the speed of a good running wagon to that of a "bad runner" in advance of it.

Mention is made of the adverse influence of strong winds on hump shunting movements, and the reporter gives illustrations of cases where artificial protection is provided. Poplars form a natural protection—as provided, we would remark in passing, at La Délivrance yard, Lille—but from eight to ten years must pass before they are effective. Fixed signals for instructing the driver to stop, push slowly, or to push at moderate speed are also described. Communication with the driver by a wireless installation has been successfully tried in flat yards, but it is not suitable for gravity yards on account of the brakesmen having to be in various parts of the yard.

What is a novelty is rope shunting, which, like power-operated rail brakes and slipper brakes, "consists in the control of the humping speed being placed in the hands of one man only—the head shunter—who is posted at the point when the humping begins and who can watch the working of the train and the progress of the wagons. By doing this the humping speed can be varied quickly and safely and can be adapted to prevailing conditions."

The first controlled rope-shunting yard was that at Dresden-Friedrichstadt. It was opened in 1928, and consists of a small truck that runs between guides laid in the four-foot, and weighted so as to prevent it being lifted. Attached to the truck is a heavy arm, at the end of which is a hook which is coupled to the last of the rake of wagons to be shunted. An endless rope is used and it passes round the drum of a stationary engine near to the top of the drum, and thence down one road of the hump, over a wheel—which is kept in tension by weights—and back by another road and over the drum. The rope truck thus pushes any wagons necessary to the summit of the hump and checks their descent afterwards, and when it gets to the foot of the incline it is transferred by points on to an ascending road and brought back to the top. This arrangement seems to us very like the working of the incline railways in Durham.

It is reported that "the apparatus works faultlessly; it has not failed even under unfavourable weather conditions" A similar plant was being installed at Chemnitz-Hilbersdof, which it was expected would give a considerable increase in the output.

It appears from Dr. Gottschalk's report that as well as retarding apparatus there is also means for accelerating the trucks. The object of this is to make comparatively low humps suffice and to accelerate the travel of "bad runners," so that they will move more quickly and so equal the speed of a freely moving wagon. The first apparatus of that character was installed in 1924 at Seddin, and one was brought into use in February, 1929, at Osnabrück.

It is thought that this arrangement would be useful in yards where it would be difficult to increase the height of the hump, and in those where siding points are at such a distance from the foot of the hump that slowly moving wagons do not travel far enough to reach the siding intended. The latter is a feature which, during unfavourable weather, sadly interferes with shunting operations. It is remarked, however, on the general question, that the installation is still in the experimental stage and it is too early to arrive at a final opinion of its value.

SUBJECT XII.—ECONOMICAL TRACTION METHODS FOR USE IN PARTICULAR CASES.

On this subject Report No. 1, by Mr. R. H. Nicholls, superintendent of the line, Great Western Railway, applies to America, the British Empire, China and Japan.

The Canadian National Railways were led to consider the possibilities of the self-propelled type of passenger equipment, as it offered the advantages of a reduction in the size of train crews, relatively low maintenance expense and greater availability than can regularly be obtained from steam locomotives. Between 1921 and 1923 six storage-battery cars were introduced, but they are only suitable for very short runs. In 1925, nine oil-electric cars were put into service. They are equipped with light Diesel engines, driving through an electric transmission system. The experience with these cars, and their ability to convert an operating deficit or extremely small margin of net return on light passenger traffic returns, led to the building of five more oil-electric cars in 1927. It is contemplated that the use of the oil-electric car will be extended in the future and the petrol-electric to a lesser degree.

On the South African Railways the only motor vehicles were, at the time of writing, Sentinel steam car and a few petrol-driven vehicles which are used in experimental services.

The London, Midland and Scottish reports that Sentinel-Cammell steam rail coaches have been introduced to cope with the passenger traffic on the minor lines and 13 of them were put in service in 1927. The short time the vehicles have been in service is hardly sufficient to enable a decision to be given in regard to future extension, but valuable data are being obtained as to the usefulness and capacity of this type of vehicle for passenger work on branch lines and on sections of the line carrying little traffic.

The London and North-Eastern has 44 Sentinel-Cammell steam rail coaches of the "Clayton" type, and a petrol rail coach. No decision has been reached in regard to the extension of the use of the steam rail coaches to meet future requirements.

The opinion of the Southern Railway is that on its system there are many instances where the traffic on branch lines is comparatively small, but of a general nature, and the motive power employed on the branch lines is required to work passenger, goods, timber, cattle, milk and other traffics. Hence the economical employment of a specially constructed vehicle, such as a steam rail coach, is precluded.

On the Great Western there were, in 1907, 80 steam rail motor cars—that is, we would interpolate, of the type designed by Mr. Dugald Drummond and Mr. T. Hurry Riches—but that number has gradually decreased to 39. Generally speaking, these rail motor cars have been superseded in consequence of their lack of power and capacity to cope with extra traffic which may arise in various circumstances. The maximum loads up severe gradients are comparatively light and allow very little margin for extra vehicles to be attached. The method of working what are known as "auto trains" has superseded the rail motor cars, except on branches and sections of the line where the passenger traffic is fairly light. The "auto train" consists of a small tank locomotive, with coaches attached to it, in front or behind, and, in some cases, at both ends, in such a way that the locomotive can be driven from either end of the train, thus obviating the necessity of the locomotive running round its train at terminal points. The rail motor services are now 15 as against 33 in 1907, but the auto trains are 75 as compared with 14.

Report No. 2, applicable to all countries except America, the British Empire, China, Japan, Belgium, France, Italy, Portugal, Spain and their Colonies, is by Mr. H. Hunziker, of the Swiss Federal Railways.

He reports that on the Danish State Railways there are six Diesel locomotives, 22 petrol rail motors and 4 Diesel rail motors. The appreciable saving that has followed the employment of the latter two has led to a decision to extend their use. Other countries have supplied what, to us, appears meagre information. However, the conclusion of this reporter is: "From the data supplied it appears that the Diesel electric rail motor coach offers the greatest advantages, owing to its cheap cost of operation and that it can stand a certain overloading. The possibility of using one man to drive these vehicles results in important savings."

For Belgium, France, Italy, Portugal, Spain and their Colonies, Mr. O. A. Gaeremynck, of the Belgian National Railways Company, presents Report No. 3. Therein we read that the Paris, Lyons and Mediterranean has four steam rail cars in use, which are the last of twelve bought in 1907. They will shortly be withdrawn on account of the high maintenance cost. The Belgian National Railways Company tested, in 1929, a Diesel rail car. The results being considered satisfactory, three others have been ordered.

In Report No. 4, for Germany, Mr. Leibbrand, a director of the German State Railways, rather devotes more attention to the legislation and organisa-

tion of secondary lines than to economical traction on them.

Part (6) of Subject XII. relates to the use of special tractors for shunting in smaller yards and for certain work in large yards.

Mr. Nicholls reports that the London and North-Eastern has, for these purposes, Sentinel steam locomotives, Simplex petrol locomotives and two types of road tractors. That company says that no special difficulties have been experienced with the introduction of the special types of traction and the results so far are quite satisfactory. The use of power units is, however, in the experimental stage, and sufficient experience has not yet been gained to give detailed figures of maintenance and of cost of repairs. The tendency is to replace horses by power units where this would be advantageous and economical.

On the Southern Railway three tractors do the work at Nine Elms that previously required nine pairs of horses, and their introduction has undoubtedly accelerated the shunting work. The tractors cost £260 each and the maintenance per tractor is £170 a year for repairs and £25 for renewal and depreciation.

In six yards on the Great Western, where there are physical difficulties, *e.g.*, sharp curves which prevent the use of ordinary shunting engines, five petrol-driven locomotives and one Sentinel steam locomotive are employed. The last-named will haul 84 tons up a gradient of 1 in 51 whereon there are curves of 160ft. radius.

The report for America by Messrs. H. B. Voorhees and Geo. H. Emerson, both for America, is not yet to hand.

Section VI.—Light Railways and Colonial Railways.

On the subject of "Improvements in the Permanent Way of Light Railways," there is a report by Mr. Van Noorbeeck, which, as becomes the work of a director of the Belgian National Light Railways Company, is full of information—it has 24 drawings. The reporter says that light railways have copied the measures issued by the large lines, although the construction and working conditions often are not comparable. He is sorry to see the application, pure and simple, to light railways of certain methods used on lines carrying heavy and fast traffic and regrets the absence of any extension to the local railways of certain arrangements used on tramways. At the present time particularly, light railways find themselves in very difficult economic conditions and should inquire very closely into all details of the track and reduce to a minimum the cost of construction and upkeep.

A report by Mr. L. Sekutowitz, of Paris, on the "Electrification of Secondary Lines," is noticeable for the confession in the conclusion that if we look at the economic side of the programme the question is much more delicate than when we are on technical grounds. In fact, the secondary lines differ from each other on many points, but present, in general, the common feature that the traffic is only light. That is to say, the saving in coal to be expected from the general use of electric traction on such lines is, in general, small in absolute value. The saving resulting therefrom is but rarely sufficient to warrant the cost of electrically equipping the lines and of purchasing new rolling stock. That is a great obstacle to the use of electric traction on those lines. Electrification is only possible in cases in which the technical advantages of this method of traction dictate its use—difficult gradients, new lines, &c.—or when electric energy is available at a low price while coal is dear. In most cases, only when there is relatively heavy traffic, requiring at least ten trains a day in each direction, can electrification be a paying proposition, even for a new line.

Meetings of the Congress.

Having now completed our abstracts of the papers, we may pass on to a consideration of the work of the Congress itself, which was opened in Madrid by the King of Spain on Monday, May 5th.

The International Railway Congress is very representative in its constitution. It is allied with forty countries, a term which also covers the colonies of those countries which possess them. The International Railway Congress Association, which is at the head of its affairs, is not only composed of privately owned railways, as in Great Britain, but of those that are State-owned. Moreover, the Governments themselves of the countries which have railways are members of the Association, together with international organisations which deal essentially with railway operation, *e.g.*, the Compagnie Internationale Wagons Lits, the Railway Clearing House and the Union Internationale des Chemins de fer.

The outstanding feature, as regards representation, of the present Congress, is the sudden advance to the front of the German railways. There was a time when, owing to the existence of the German Railway Union, the railways of that country saw no necessity to join the Railway Congress, but, having changed their minds, they were very much in evidence at the Berne Congress in 1910. Such progress, in that relation, was made, that the German Government invited the Congress to meet in Berlin, after the then usual interval of five years, in 1915. The war, however, not only prevented that, but created difficulties with the Association itself. Its offices were in Brussels and, being international in its character, some of its property was enemy-owned. The Congress had, therefore, to go into a kind of voluntary liquidation and to remove its headquarters to Havre. Germany was not, as a consequence, represented at Rome in 1922, nor in London in 1925. On the latter occasion an invitation was sent, but not without opposition, to the "enemy countries" to rejoin the Congress, and it was accepted. It is significant that, now, twelve of the ninety-six reporters to the Madrid Congress belong to the German State Railways Company. Another significant fact is that whilst for London there was only one reporter from Japan there are now four; there are also four from Czechoslovakia, two from Yugoslavia and one from Roumania. The presentation of reports by the officers of such minor railways as the three last-named is of particular benefit to colonial and overseas railways, which look for guidance more to lines of similar standing and traffic to their own than to the big railroads. But, perhaps, a greater event than the restoration of German railways to the front rank is the falling-off of the Americans. After the Congress met in Washington in 1905, the railways of the United States got quite enthusiastic over, and interested in, its welfare. The result was that for Berne the names of the delegates filled twelve pages of the programme. At Rome, three pages sufficed, and London required less space still, but this year there are only five American companies, which have seventeen representatives! Whilst the abstention of the American railroads is to be regretted, on the ground of the consequent lesser general representation of all the railways of the world and because of the financial loss, it has to be remembered that, in many ways, the systems of the United States are not typical. They are uncommon in their vast business, varying density of traffic, long hauls, great distances, heavy locomotives and cars and their financial position. The accession of Germany may be said, when the whole position is weighed up, to do more than counterbalance any loss caused by the defection of the United States.

Some may be disposed to consider that the social and pleasure side of the Congress receives too much attention and that the opportunities for real business are proportionately few. It must be remembered, however, that the meetings are the conclusion of a good two years' hard work. Some three years or so before each Congress reporters are selected by the permanent Commission, which, as representative of all railway systems, sits in Brussels, to report on various phases of railway administration, construction, maintenance, operation and finance. These reporters are allotted to given countries, to whom, on their behalf, questionnaires are addressed, and on the replies thereto the reporters make a summary of the salient points and draw their conclusions, which may be regarded as the considered practice of the world. It is these conclusions that the Congress, divided into five sections, considers. It then draws up the recommendation of the section concerned and submits it to the Congress, in full meeting, to approve or amend. Thus the groundwork is laid before the Congress opens, first by the reporters and then by the delegates in their study of the reports.

Business began on Tuesday, May 6th, when Section I.—under the presidency of Sir Charles Morgan—discussed, with Section III., the question of the relations between railways and seaports. Dr. Wechmann was the chairman of Section II., before which the question of locomotives of new types—The Engineer, May 2nd—was considered under two heads:—(1) Steam locomotives; (2) internal combustion locomotives. On the former of these two heads, Sir Henry Fowler said that the London, Midland and Scottish had made experiments with a locomotive of the Ljungström type. No trouble had been experienced as regarded the main principles, but there had been many difficulties with minor details. To get the best work out of a turbine, it must run at constant speed. That could not be done on a railway with varying gradients, as the speed changed from minute to minute. An important matter was cost and maintenance. The condenser necessitated high first cost and introduced a delicate piece of mechanism. On the whole, the increase of economy was not great, and Sir Henry thought that it would be a long time before the turbine could be applied economically to locomotives. Mr. Bianchi (Italy) asked if it was necessary to have a condenser, to which Dr. Nordmann, the reporter for Germany, answered that a turbine locomotive without a condenser had been tried, but it had to be withdrawn from service. Mr. Koller (Czechoslovakia), another reporter, agreed with what Sir Henry Fowler had said as to the difficulties, owing to varying speeds. He added that some firms were building engines without condensers.

The discussion under the same heading was continued but in relation to high-pressure locomotives. Mr. Weiss (Switzerland) remarked that he had carried out some experiments with the Winterthur locomotives in regular service, and had obtained a coal economy of 30 per cent. Mr. H. N. Gresley observed that in the high-pressure locomotive on the London and North-Eastern simplicity of design had been the main point. The pressure had therefore been limited to 450 lb. per square inch, and particular care had been taken to reduce loss of heat by radiation. The engine ran very satisfactorily, and the amount of scale in the boiler was practically negligible.

The discussion on steam locomotives was carried forward to Wednesday, the 7th. When it was concluded and the question of the internal combustion locomotive was reached, Dr. Wechmann, the chairman, observed that the method of transmission was one of the essential matters. On that point, Sir Henry Fowler remarked that the L.M.S. Diesel locomotive employed electricity for transmission, which at once increased the first cost. A trouble was that the engine could only be used for twelve to fourteen hours a day. If it could have been kept at work for twenty to twenty-two hours it would have been better.

A recommendation came before Section II. that the possibility of creating in Europe an international experimental station for scientific tests on railway rolling stock should be studied. Mr. Gresley told the meeting that a committee had been sitting in England on that subject for twelve months. It had come to its conclusions, but the report had not been published. Mr. P. Wagner (Germany) thought that the question should be carefully weighed, in view of the losses railways were experiencing from the competition of road motors and aircraft. Mr. R. André (Spain), on the other hand, thought that the losses named were only passing.

The discussion on Improvements in the Steam Locomotive—Question 6—had to be brief, as the section had already extended the time limit. In it Sir Henry Fowler observed that the exhaust steam injector on the London, Midland and Scottish had been so satisfactory that it had been made the standard. It effected a saving of 7 per cent. In relation to valve gears, good reports as to the Caprotti valve gear were made by Mr. Bianchi and Sir Henry Fowler.

On Thursday, the 8th, Section II. opened and concluded its consideration of Electric Locomotives for Main Line Traction—The Engineer of May 9th. In the discussion Monsieur Leboucher (Midi of France) remarked that whilst geared electric locomotives resulted in less wear on the track than steam locomotives, that was not the case with the gearless type. In answer to a question by the chairman, Monsieur Leboucher said that whilst a speed of 72 m.p.h. was specified in the gearless locomotive, that type was so unsatisfactory at even 60 m.p.h. that radical modifications had been necessary. The discussion was then adjourned until Monday, the 12th, when it was concluded, and that on All-steel Coaches begun.

We may add here that at the conclusion of the Congress, the recommendation of the Permanent Commission was that the twelfth session be held in 1933 in Cairo.

(To be continued.)

American Engineering News.

Reclaiming Sand in Steel Foundries.

Moulding sand in steel foundries is an expensive raw material and its consumption is said to average 1000 lb. per ton of castings. After the sand is shaken out from the moulds a portion goes back to the sand preparing machine to be mixed with new sand and the necessary bonding admixtures so that it is used over again in making moulds. But a large proportion of the used sand has to be thrown away, as it has lost certain properties which fit it for mould making. Experiments as to this deterioration of the sand have shown that contact with the molten steel develops ferrous silicates, which would increase rapidly if the same sand was used repeatedly. The binder—whether clay, starch or pitch—remains as a coating on the sand grains. In the used sand, therefore, the quartz grains are surrounded by binder material more or less oxidised and decomposed, as well as some ferrous silicate from the face of the mould. Whether the sand grains themselves suffer a deterioration is uncertain, but tests made by Mr. Dierker at the Buckeye Steel Foundry indicate that only the grains in contact with the metal are broken up and should be removed in the cleaning operation, as they absorb ferrous iron. An experimental apparatus recovered some 70 per cent. of the sand, and a full-sized plant in a typical week's operation recovered as good sand 85 per cent. of 1,177,700 lb. of sand treated.

Toll Road Revival.

One result of the enormous and continual increase in the number of motor vehicles is a revival of the old idea of toll roads and turnpikes, the modern toll roads being private enterprises for the patronage of high-speed travel, where ordinary road traffic conditions limit the possibility of continued speed. One such road is planned between Detroit and Pontiac, 25 miles, paralleling a broad public road. Still another is between New York and New Haven, 70 miles, and a third from New York to Ronkonkoma 50 miles. There are some short ones to special scenic points, such as the one up Pike's Peak. The new roads would be partly elevated, with no level crossings, and would have access only at a few points by means of ramps or inclines. The ostensible purpose is to relieve traffic congestion, but the underlying idea is to cater for the demand for high speed. Toll roads were in operation to some extent in the United States for about 100 years, the original idea of the charge being to provide for repair and maintenance. Some of them were operated by the several State Governments and others by private companies, but the latter were gradually bought out as rapid railway development reduced the use of roads for long-distance transportation. A commission is to be appointed by the Government to consider the merits and demerits of a pro-

posed system of express or high-speed motorways connecting the principal cities. The proposition seems rather far-fetched, but with self-propelled vehicles capable of running 50 to 70 miles an hour, but limited in speed by traffic congestion and cross roads, it may become practicable and desirable.

Artificial Manganese Ore.

In view of the limited resources of manganese ore in the United States, experiments have been made in the production of such ore by treatment of the manganiferous iron ores, of which there are large deposits. The purpose is to recover the manganese in a form suitable for the production of ferro-manganese or the 80 per cent. alloy which is indispensable in producing steel. Of the two types of manganiferous iron ores, the brown is higher in iron and lower in manganese, while the black is more siliceous but contains less phosphorus. The best method appears to be the utilisation of the iron content of the brown ores in the production of steel, and the experimental investigation has been in working out modifications of iron and steel practice in order to recover manganese in the form of slag that is comparable with manganese ore. Both blast-furnace and open-hearth practice have been studied, and more recently it has been developed that the high phosphorus spiegel produced from manganiferous iron ores can be treated also in the electric furnace. This investigation is of particular importance in view of the tendency to require higher manganese content in steel specifications. At present about 14 lb. of metallic manganese are required per ton of steel, and the quantity is the same even when manganiferous ores are used as part of the charge. In the modified process, the manganiferous ore composes the entire charge, producing high-phosphorus spiegel with 10 to 15 per cent. manganese instead of basic pig iron with 1½ to 2 per cent. This spiegel can be treated to concentrate the manganese in a slag containing 55 to 70 per cent. of manganous oxide. The experiments indicate that large quantities of ferro-manganese can be produced from the manganiferous iron ores.

Warehouse with Roller Conveyors.

In the eight-storey warehouse, 300ft. by 100ft., of the Western Electric Company, an extensive system of inclined and horizontal roller conveyors is provided to handle material from the storage shelves or bins to the packing department, and thence to the shipping platforms. For machinery, a large part of the packing is done on the conveyors, which give a speed of about 8ft. per minute. For this work, the machine or part is handled by the chain sling of an overhead hoisting trolley, which lowers it upon a frame which will form the bottom of the box or packing case. Then the interior packing and the sides of the box are applied and nailed as the load travels along, there being three parallel lines of these conveyors. Similar conveyors deliver empty boxes to the packers. In some cases the live rolls alternate with dead rolls and are carried in a separate frame. The packer operates a switch causing the frame to drop and leave the packages stationary on the dead rods while he does the necessary packing and nailing. By throwing the switch, the live rolls come up into contact with the packages, which then move on. Sharp curves are turned easily by these conveyors, and in some cases they are built as spirals to lower goods from floor to floor. Numerous runs of conveyors deliver packages to the sorting and marking places, and then to the parcel post station or to the shipping platforms. Automatic switches or guides direct packages to special lines of conveyors, and hinged sections of the conveyor lines can be raised to permit moving trucks across the floor. Hinged curved sections also carry packages directly into the covered railway cars for shipping.

Strengthening Railway Bridges.

One result of the continual increase in size and weight of locomotives on American railways is the necessity of strengthening many bridges not designed for these new loads, as it would be impossible to replace all of these structures with new bridges as fast as the new engines are built. About twenty years ago the maximum axle load was 25 tons, while nowadays it runs as high as 35 tons. A recent paper by Mr. Haggander, bridge engineer of the Burlington line, points out how the older bridges are examined, classified as to strength and reinforced. In rare cases, trains may be required to cross at slow speed, or have temporary falsework put under them. But there is always doubt as to how a "slow order" will be obeyed or enforced, and falsework is usually out of the question for spans over streams, owing to the possibility of flood, ice, and drift. Girders and trusses may be reinforced by additional or new cover plates, web plates in chords or booms, additional flange angles and stiffeners in girders, and strengthened web members and connections in trusses. In the floor system, additional joists for longitudinals or additional cover plates on plate girder longitudinals and cross girders may be applied. With eyebars in pin-connected trusses, these members may be supplemented by rods attached to loops over the pins and drawn to the required tension by means of turnbuckles. Much of the work requires riveting, but in many cases welding is convenient and advantageous, and its use in this class of work is increasing. In deck spans, a third or middle truss or girders is sometimes applied, but with double-track bridges this involves rather complicated work.

Concrete Conveyors.

Placing concrete in the forms or moulds by means of belt conveyors is being used extensively as a rapid and convenient method which also gives a good grade of material. In some cases the conveyor is a long continuous unit, but, in general, a series of units about 45ft. long is more convenient, and gives greater flexibility of arrangement. At the Merchandise Mart, in Chicago, 142,000 cubic yards of concrete, covering about 1 acre of floor, were placed in this way per day. Each of the forty-four conveyor units consisted of a steel Warren truss, pivotally mounted on a frame carried by caster wheels to facilitate ready movement to any position. Each unit had its own motor, served by a flexible cord connection. The conveyors were slightly inclined, so that the concrete dropped from the high end of each one to the low end of the next, this drop serving to keep the concrete well mixed and to prevent segregation. For walls, piers, &c., the concrete may be handled by conveyors at angles up to about 35 deg., the steeper angles being practicable with fairly dry concrete made with small-sized coarse aggregate. A 24in. width of belt is the minimum to prevent spilling. Its speed should not exceed 300ft. per minute, as with higher speed the belt will move faster than the concrete, which slippage results in increased wear on the belt. A wiper or spring scraper at the discharge end prevents concrete sticking and going back on the return side of the conveyor. On a dam 1000ft. long and 375ft. high, the conveyors were slung on booms from steel towers in which the concrete was hoisted by buckets. In this way the conveyors were raised as required and could be adjusted to any desired horizontal or inclined position.

Natural Gas Developments.

Although the natural gas resources in some parts of the United States have been practically exhausted, there are now enormous developments in Texas and California, and a remarkable feature of this is the piping of the gas to manufacturing centres several hundred miles from the gas wells. In the earlier days of oil development, much of the gas was allowed to go to waste as a by-product of little use or value, but laws regulating this industry now require operators to prevent such waste. In California alone one company has some 700 miles of pipe line, 10in. to 20in. diameter. A 22in. pipe line extends to Denver, 350 miles, and another from Louisiana to St. Louis, 530 miles, while one of nearly 1000 miles will deliver gas to Chicago. In spite of the reckless waste of these valuable natural resources, new fields of oil and gas are being discovered, and where groups of wells 4000ft. deep have seemed to be exhausted, new supplies are developed by still deeper wells. While oil is the main product sought, the new laws make it necessary to conserve and utilise the gas. For transmitting potential energy in the form of gas through a pipe line, the cost is about half that of equivalent electrical energy transmitted by cables. Gas pipe lines are much larger than those for oil, with a maximum of 26in. or 28in.; compressor stations are 90 to 100 miles apart, and low temperatures do not affect the flow of gas, as they do with oil. In general, the pipes are welded, and with the extensive and rapid construction of these lines special apparatus and methods have been developed for speedy, effective, and economic construction.

Direct Recording of Cross Sections of Civil Engineering Works.

AN instrument for the direct recording of cross sections of civil engineering works is illustrated by Fig. 1. This instrument, although we understand that it has not yet reached its final form, was used with marked success in the taking of cross sections in the 15-mile rock tunnel of the Lochaber Water Power Scheme. This tunnel, our readers will remember, was excavated to about 16ft. in diameter, and the instrument was designed primarily to deal with sections of that size, although it was also used in some foundations for dams and other irregular excavations.

Briefly, the instrument consists of a rigid framework A pivoted on what might be described as a plane table B, in which a ball bearing is fixed. It will be understood that in the drawing the apparatus is shown horizontal, but that for such work as that in a tunnel, the table is arranged vertically. The frame, which is balanced by a counterweight C, is free to take up any position in azimuth. It carries a drum D about 4in. diameter, which contains a large spring of the gramophone type, while about 20ft. of non-elastic cord are contained in a spiral groove cut on its periphery. This cord, on being pulled, is unwound from the drum against the action of the spring. Its free end passes through guides, which are so arranged that the longer axis of the instrument is caused to assume the same direction as the cord. One turn of the drum represents 1ft. of cord. The drum is geared to a smaller drum D¹, which, by means of an endless cord, operates a cursor F, which carries a pencil. This cursor, which is spring controlled to prevent backlash, follows the movement of the cord E, being moved radially from and towards the central hub, according as the cord is unwound from or rewound on the drum D, the distance it travels through bearing a definite scale ratio to the length of cord drawn out. The plane table carries a sheet of cartridge paper, and is mounted on a tripod or trestle to suit the conditions. Normally, the pencil is kept from contact with the paper by a spring, but, when it is desired to make a record, it can be pressed on to the paper by means of a Bowden wire or similar arrangement.

The operation of the instrument is simple. The table is set up in the plane of the required section and its exact position with regard to line and level ascertained. In the case of most of the Lochaber tunnel sections, the centre of the instrument bore a constant relation to the centre line and invert level of the tunnel, the instrument being supported on a trestle sliding on two rails some 9ft. apart, previously set to line and level for the purpose of carrying travelling trimming carriages and concreting shutters. Having thus arranged the instrument, a polar diagram is readily obtained by passing the extremity of the cord, affixed to a bamboo pole, around the periphery of the tunnel, care being taken to follow its irregularities. The pencil, which has been pressed on to the paper, moves directly in accordance with the varying length of the cord, with the result that an outline of the excavation is obtained. Fig. 2 is a facsimile to a smaller scale of one of the records obtained in the Lochaber tunnel, an outline showing the concrete lining having been subsequently added. The scale adopted in actual practice was ¼in. to 1ft.

In order to ensure that the cord is maintained in the correct plane, a small electric bulb G and lens H are arranged on the frame to throw a spot of light on the tunnel wall, so that the operator only has to keep the end of the cord in the illuminated patch, as it travels round, in order to be sure that the cord is in a direct line with the frame. This device enables very accurate diagrams to be made. In fact, we are informed that frequent tests have shown that the accuracy obtained compares most favourably with that of the "sunflower" and other methods. The advantage of having an actual diagram on which special notes and sketches can, if necessary, be made on the spot is obvious, while the elimination of laborious plotting in the office is also an important matter where many sections are involved.

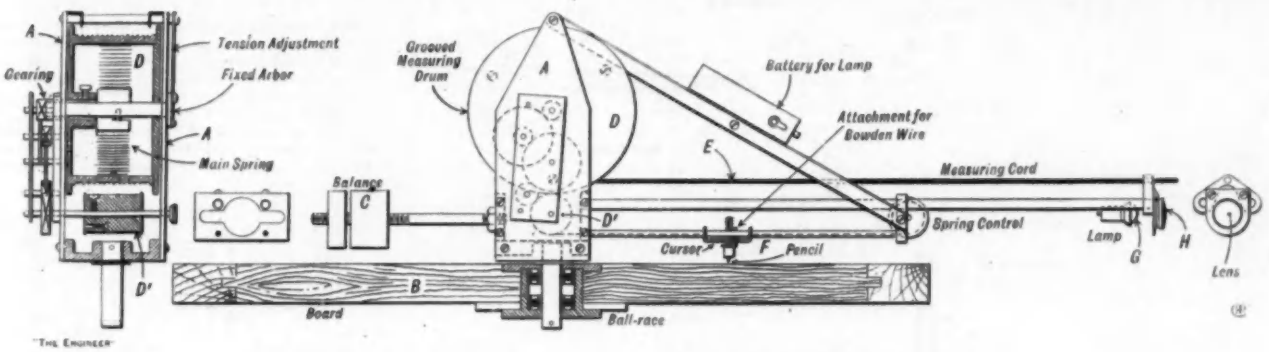


FIG. 1—DUNCAN'S CROSS SECTION RECORDER FOR CIVIL ENGINEERING WORKS

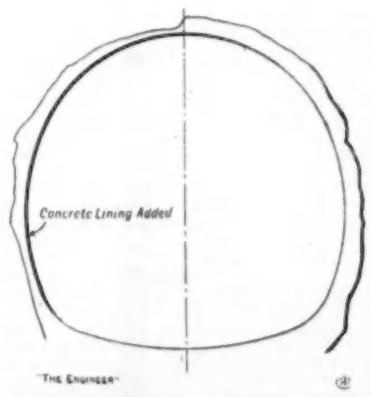


FIG. 2—REDUCED FACSIMILE OF A TYPICAL RECORD

The instrument was designed and first put into use in 1926 by Mr. R. D. Duncan, B.Sc., Assoc. M. Inst. C.E., Senior Assistant Engineer on the Resident Engineer's Staff of Messrs. C. S. Meik and Halcrow, the Consulting Engineers for the Lochaber Scheme. He claims that there is a field for this instrument in several directions, such as in irrigation work, and in the survey of small areas, either in the vertical or horizontal plane. The size of the work done is only limited, he points out, by the increasing inaccuracy which would occur owing to sag if very long cords had to be used.

The development of the idea is in the hands of Messrs. E. R. Watts, instrument makers of Camberwell, and 104, Victoria-street, Westminster, S.W. 1.

Testing Plant for Overhead Line Transmission Towers.

WITH the rapid development of overhead transmission lines and their increasing importance for distribution and interconnection of power, reliability is of essential importance, particularly where in case of failure of the line an alternative supply would be insufficient or unavailable. To that end it is necessary to ensure that the conductors and supports should have the requisite strength to withstand the extremes of loading to which they are subjected by climatic conditions, yet not be so heavy as to become unreasonably strong and uneconomical.

The actual loads which a tower supporting the conductors has to withstand are estimated beforehand, and the tower designs are based on the figures so obtained. Some engineers satisfy themselves as to the suitability of a tower by studying the design and stress calculations and ensuring that accepted theories and methods are adhered to. It generally happens, however, that in each method of computation certain conditions have to be assumed, and it is impossible for these conditions to be fully realised in practice, with the result that the tower is liable to be either too weak or unduly heavy for its purpose according to whether the assumptions of the designer are optimistic or otherwise. Also, the accuracy of workmanship and such things as bolt hole clearances and joint details can have a considerable effect upon the strength of a tower.

Full-scale tests on actual towers can therefore be of great value to the designer by determining how far his theories are substantiated and proving the efficiency of connections and workmanship. Moreover, much greater confidence can be placed in a design which has successfully withstood actual tests to full overload, and it is now regularly specified by various authorities that such tests must be carried out.

Realising the great advantage, or even necessity, of adequate equipment for testing these towers, the General Electric Company, Ltd., has put down a complete testing plant at its research laboratories at Wembley. The plant was designed in co-operation with the engineers of Brown, Boveri et Cie., whose extensive experience on the Continent was of great value, and was erected by Pirelli-General Cable Works, Ltd., which, in association with the G.E.C., carries out the erection of its various overhead transmission contracts.

To allow for future progress and development, the plant was so constructed as to be suitable for testing transmission towers much heavier than anything that has as yet been contemplated in this country. The 132,000-volt "grid" scheme of the Electricity Commissioners, which is the greatest undertaking in Great Britain, has conductors the equivalent copper section of which is 0·175 square inch. The G.E.C. testing plant will accommodate towers for systems having steel-cored aluminium conductors of 40 per cent. greater conductivity, i.e., 0·25 square inch equivalent copper area, the maximum working tension of those conductors being about 5½ tons. The plant will test double-circuit towers up to 100ft. high, with two earth conductors for terminal positions or for line deviations up to 60 deg. For such a double-circuit 60-deg. angle tower designed with a factor of safety of 2·5, with allowance for wind load, for a test representing working conditions there will be eight pulls of about 15·6 tons each, producing an overturning moment at ground level of over 10,000 tons-feet. Tests representing broken conductor conditions can also be applied for any number of broken conductors up to the total of eight, a lower factor of safety usually being taken for this abnormal condition. For all conductors broken in one span there will be eight pulls of about 9 tons each towards the unbroken span; if breaks occur in adjacent spans there can be up to four breaks in one direction, the remainder being in the opposite direction.

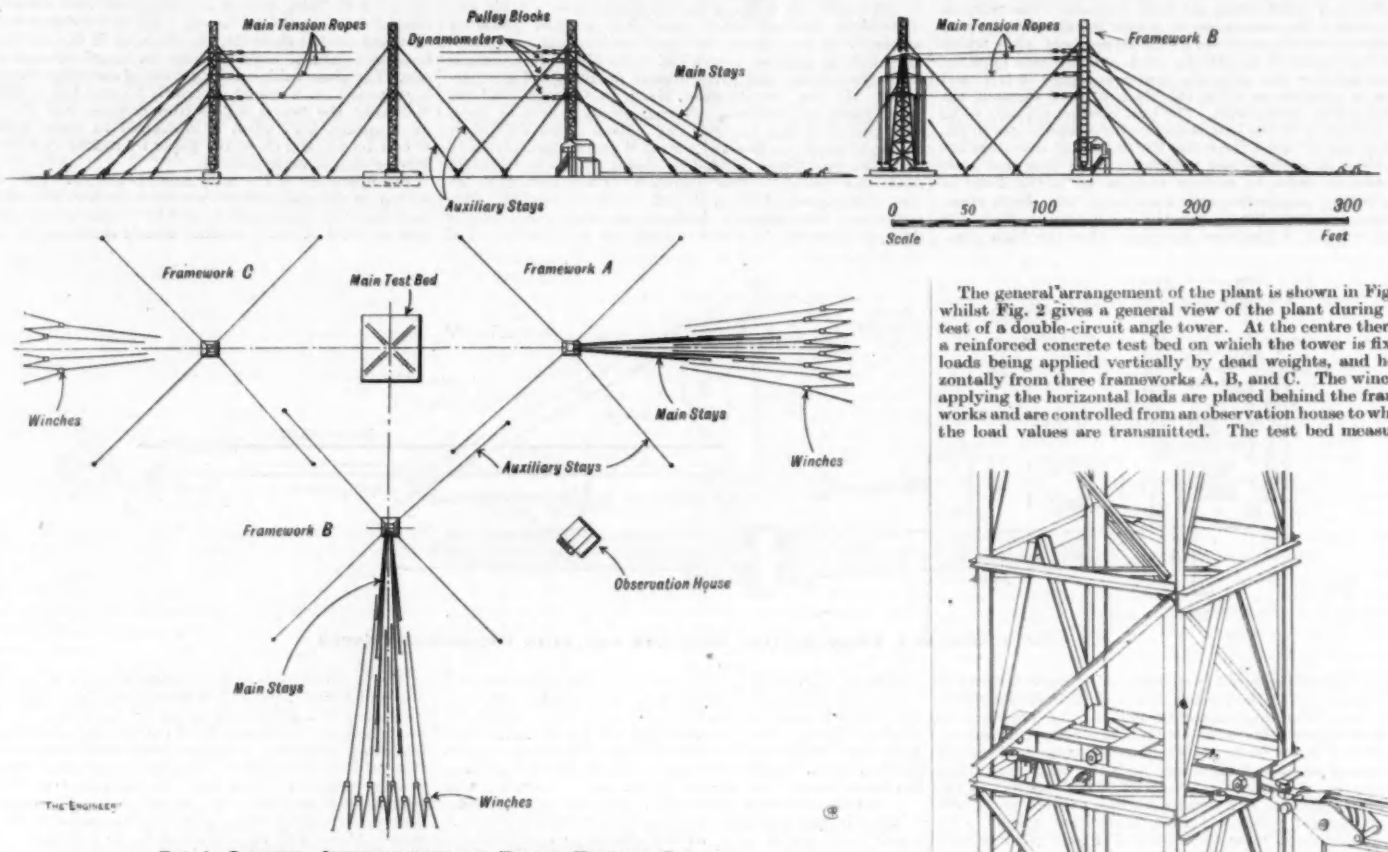


FIG. 1—GENERAL ARRANGEMENT OF TOWER TESTING PLANT

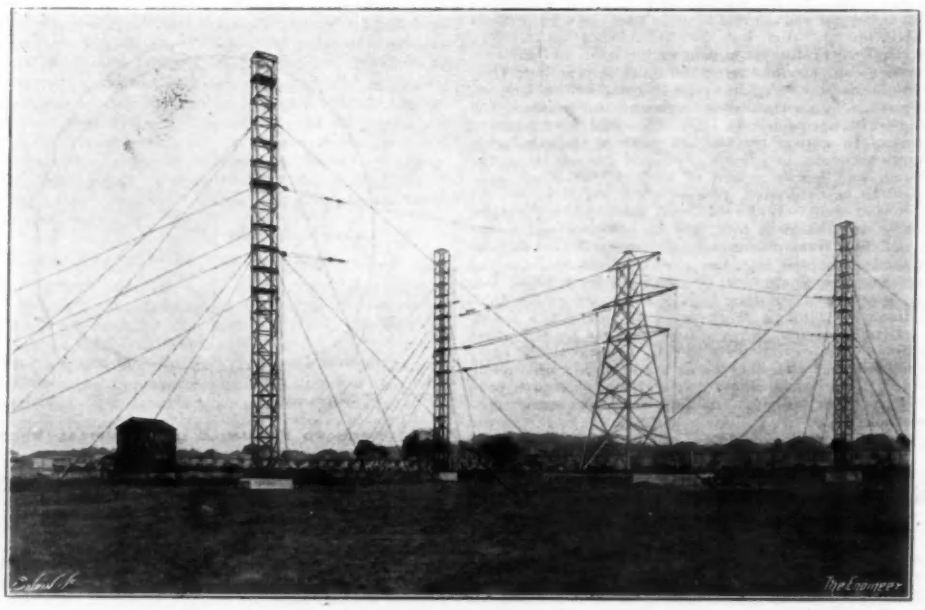


FIG. 2—VIEW OF PLANT DURING TEST OF DOUBLE-CIRCUIT ANGLE TOWER

The general arrangement of the plant is shown in Fig. 1, whilst Fig. 2 gives a general view of the plant during the test of a double-circuit angle tower. At the centre there is a reinforced concrete test bed on which the tower is fixed, loads being applied vertically by dead weights, and horizontally from three frameworks A, B, and C. The winches applying the horizontal loads are placed behind the frameworks and are controlled from an observation house to which the load values are transmitted. The test bed measures

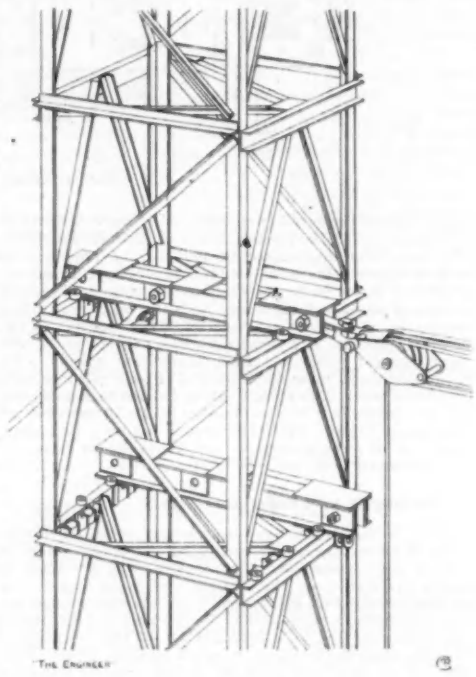


FIG. 3

43ft. by 38ft., with a depth varying from 9ft. 3in. to 10ft. It weighs about 850 tons, the weight of this foundation resisting the overturning moment of the forces applied to the tower. A series of bolts 2in. in diameter, extending to the bottom of the foundation, is arranged diagonally at right angles in two parallel rows for bolting down the tower. Any size of square-base tower can then be accommodated easily, connection to the foundation being made by steel shoes. A rectangular or other shape of tower base can be adopted by placing beams across the bed to suit the tower legs. U bolts are placed at convenient points for attachment of ropes applying vertical loads.

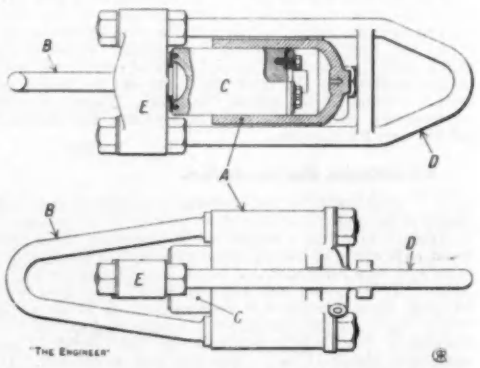


FIG. 4—ARRANGEMENT OF HYDRAULIC DYNAMOMETER

Of the three frameworks A, B, and C, framework B is the heaviest, being suitable for eight pulls of 15·6 tons, A being designed for eight pulls of 9 tons, and C for four pulls of 9 tons. The three frameworks are 100ft. high and 5ft. square and rest at their lower ends on cast steel hinge bearings. Horizontal framing is arranged at every 5ft. interval up the frameworks, so as to allow of loads being

NEW OFFICES OF "THE ENGINEER"

applied at any level from 45ft. upwards at 5ft. intervals. At the heights from which pulls are to be applied, beams which rest on rollers so that they are free to move horizontally, are placed across the framework as shown in Fig. 3. At the front of each beam are fixed the pulley blocks and tension rope connecting to the transmission tower, whilst to the rear a heavy stay runs from the beam to a grillage foundation. Loads are applied by 4-ton hand winches at the rear, from which the steel wire winch ropes run to the base of the frameworks, and thence upwards to the pulley blocks. The frameworks are subjected only to compressive loads equal to the vertical components of the stay tensions, and bending stresses are prevented by the hinge at the base. The frameworks are held upright by light auxiliary stays attached to the corner members.

The loads in the ropes to the transmission tower are measured by hydraulic dynamometers placed between the main tension ropes and the pulley blocks. The construction of the dynamometers can be seen in Figs. 4 and 5. A steel cylinder A held by a yoke B has a plunger C working in its bore. Load applied to the yoke D is transmitted by

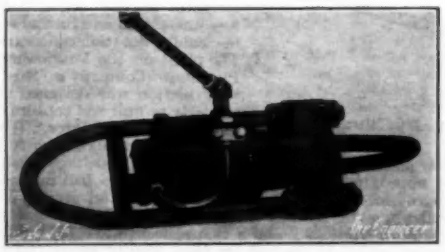


FIG. 5—HYDRAULIC DYNAMOMETER

the crosshead E to the plunger C through a spherical seating. Tension applied between yokes B and D will create a hydraulic pressure in the cylinder proportional to the applied load. The cylinder is 4¼in. diameter and at full load of 15·6 tons the hydraulic pressure is 2200 lb. per square inch. The pressure is transmitted by a length of flexible metallic tubing to a copper pipe line, ¼in. bore, going to the observation house seen in Fig. 2.

The observation house is somewhat similar to a signal cabin, the top floor being the control room, whilst the ground floor is a store room for ropes and tackle. A table having pressure gauges along the back runs along the centre of the room. The pipe lines from the dynamometers are connected to the pressure gauges, which are calibrated directly in tons. At the front of the table are push buttons which control electric signal lamps for the winches. The push button opposite any particular gauge is connected to the signal lamp controlling the winch applying the load registered by that gauge. An oil pump is fitted at the side of the table for filling pipe lines and dynamometers with oil.

The plant has been used for carrying out a large number of tests on towers designed for the Central Electricity Board's overhead transmission system and has, we understand, proved very satisfactory in actual operation. Tests already made include those on the towers which are being used by the General Electric Company, Ltd., in the contracts which it holds for the South-East England, Mid-East England and Central England schemes—the erection of which is being carried out by Pirelli-General Cable Works, Ltd.—and also a number of tests on towers being used by other contractors for the Central Electricity Board's overhead transmission schemes.

NATIONAL SAFETY CONGRESS AT LIVERPOOL.

A CONGRESS, convened by the National "Safety First" Association, will be held at Liverpool from May 20th to 22nd. The following preliminary arrangements have been made :—

On Tuesday, May 20th, at 7.30 for 8, the delegates' dinner will be held at the Exchange Station Hotel, under the chairmanship of the Rt. Hon. the Viscount Brentford, President of the Association.

On the Wednesday, at 10.30 a.m., the delegates will be officially welcomed by the Lord Mayor of Liverpool, after which the congress will be opened by H.R.H. the Duke of York. Subsequently, there will be a joint sessions with the Industrial Welfare Society, at which the following papers will be discussed :—"The Chief Causes of Industrial Accidents and the Value of Education as a Means of Prevention," introduced by Mr. G. Stevenson Taylor, M.I. Mech. E., H.M. Superintending Inspector of Factories; and "The Development of Roads and Road Transport, with Special Reference to the Prevention of Accidents," introduced by Sir Henry P. Maybury, G.B.E., K.C.M.G., C.B. In the afternoon a visit will be paid to the works of Lever Bros., Ltd., at Port Sunlight. In the evening, at 8.30 p.m., there will be a reception by the Lord Mayor of Liverpool at the Town Hall.

On the Thursday, at 10 a.m., there will be simultaneous sessions in the Town Hall to discuss (*a*) "Organised Accident Prevention," introduced by Sir Felix J. C. Pole, chairman, Associated Electrical Industries, Ltd.; (*b*) "How to Secure the Co-operation of the Operatives in Accident Prevention," introduced by Mr. John Beard, Chairman of the T.U.C. General Council; (*c*) "Street Lighting and Illuminated Traffic Signals in Relation to Prevention of Accidents," introduced by Mr. Robert Beveridge, M. Assn. P.L.E., Inspector of Lighting and Cleansing, City of Edinburgh; and (*d*) "How Local Safety First Branches can Assist in Accident Prevention," introduced by Mr. J. R. Howard Roberts, Town Clerk of Hull. In the afternoon visits will be paid to the Liverpool Docks, the New Brighton motor lifeboat, and the Canadian Pacific s.s. "Duchess of Bedford."

New Offices of "The Engineer."

IN the course of its long career, THE ENGINEER has occupied several different offices, but always in the same neighbourhood, with the exception of the years 1856 and 1857, when it was published in the City. For many years, its address was 163, Strand, a small office of genteel grubbiness, like Coutts' Bank in those days. It then moved to No. 33, Norfolk-street, an old house which some few years later was pulled down to make room for the much larger building which it has occupied up till the present time. During the interregnum, whilst this rebuilding was in progress, THE ENGINEER was edited and published from a building at the top of Norfolk-street. The present move has been necessitated by the amalgamation of THE ENGINEER, Ltd., with Morgan Brothers, proprietors of the *Ironmonger* and the *Chemist and Druggist*, which was announced in our issue of April 19th, 1929. It was felt to be desirable that the three papers should be under one roof, and that, of course, necessitated very much larger offices than those occupied separately by the two companies at that time. The new freehold building into which the three papers have now moved is shown by the illustration above. The block is a large one on the east side of Essex-street, with its back looking towards the famous Fountain Court of the Middle Temple.

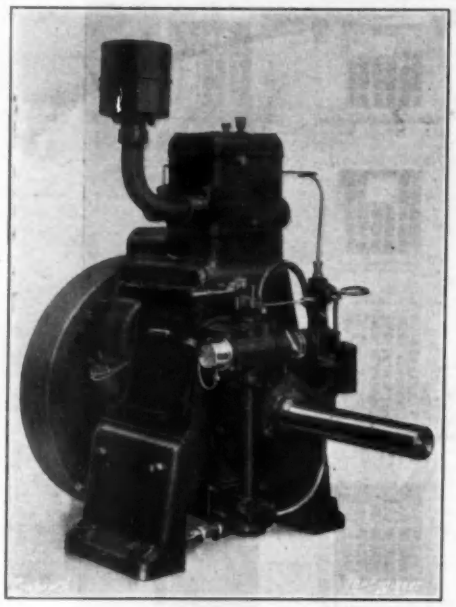
Essex-street is but a short distance from Norfolk-street and is a little bit closer to the Dragon, which stands on the site of Temple Bar and marks the boundary between the City and West End. At the foot of Essex-street is a flight of picturesque steps leading down to the Embankment. They convert the short street into a cul-de-sac as far as through vehicular traffic is concerned, no small benefit in these days when the noisiness of London streets is becoming well-nigh unbearable.

THE electric flashlight or torch, long considered safe amongst tunnel explosives, was, says the *Engineering News-Record* of New York, the cause of a premature explosion in the Boston water tunnel, fortunately harmless. It is now suspected also as the cause of an explosion last autumn in this same tunnel that cost five lives. One particular type of flashlight was found capable of producing a short circuit sufficient to detonate an electric blasting cap when the exploder wires came in contact with the case of the flashlight. This wholly unsuspected source of premature explosions may have caused other mystifying tunnel accidents in the past in which all evidence was usually destroyed, as often the entire heading crew was annihilated. Every contractor engaged in tunnel work should, says our contemporary, for the safety of his workmen, carefully test all flashlights used on the job to determine if lights of a dangerous type are being used. Fully insulated flashlights are available, and in view of the experience in the Boston tunnel, no other type should be permitted where electric detonators are involved.

A Small Heavy-Oil Engine.

AN oil engine which is capable of running on heavy oils, and is yet of such a small size that it is adaptable to minor services, has recently been produced by R. A. Lister and Co., Ltd., of Dursley, Gloucestershire. This engine is being made in several sizes and we illustrate two typical examples in the engravings below, while the drawing gives a cross-section through the cylinder.

This engine was designed by Mr. H. Ricardo. On the occasion of a recent visit to the Dursley works we saw it in production, although it was not then officially on the market. At that time the company was turning out 300 standard petrol engines per week, and it will be realised that such an output must entail a considerable organisation

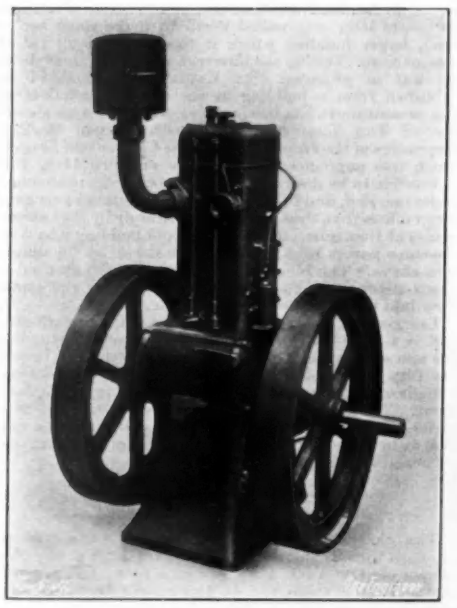


9 B.H.P. HEAVY-OIL ENGINE

and scheme of jig work. The same principles are being applied to the production of the engine which we illustrate herewith.

During our tour of the works we saw several of these engines running under load—one of them had been running continuously for five days and nights—and, at our invitation, the load was thrown on and off several times without any appreciable variation in speed and without affecting the character of the exhaust. It was not possible to try the starting of an engine from "stone cold," but one which had been standing throughout a long lunch hour, in the cold weather of January, was easily started on the first pull over of the crank handle and immediately picked up full load.

It is in the arrangements for cold starting that the

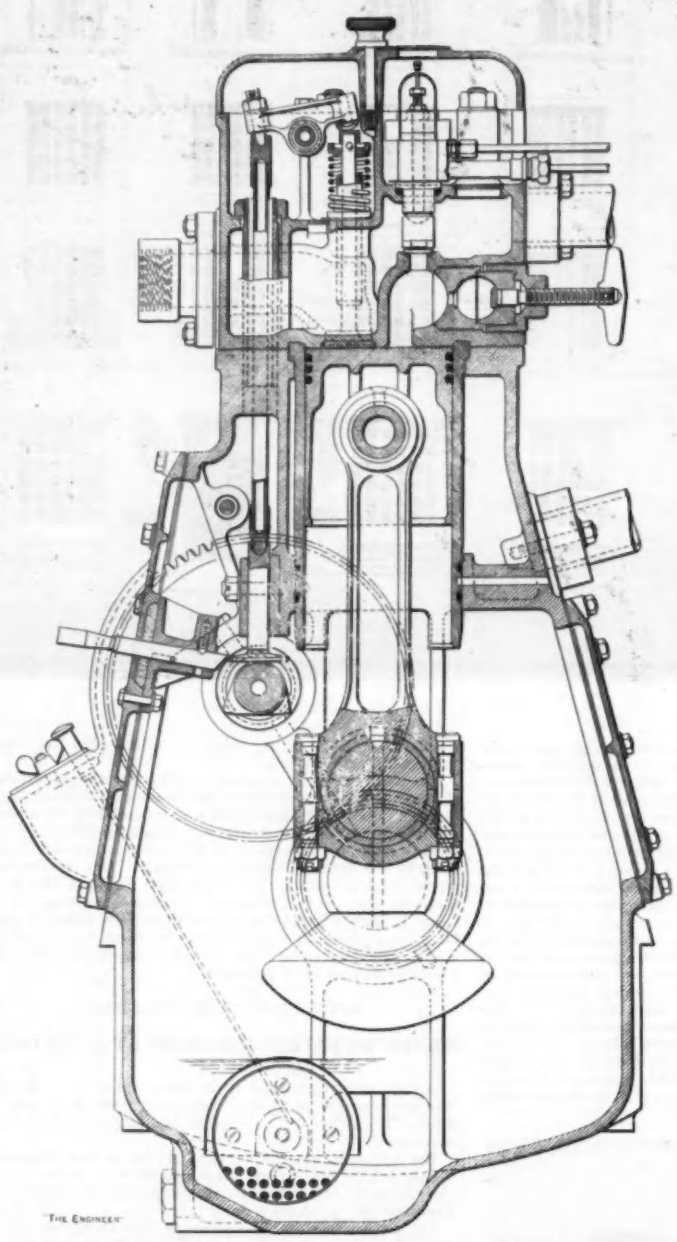


5 B.H.P. HEAVY-OIL ENGINE

engine is most noteworthy. We have briefly referred previously to the idea in our Patents columns. As will be seen from the cross-section, there is practically no clearance between the piston top and the cylinder head, but compression space is provided by a chamber above. This chamber has a tangential opening to the cylinder space in order to produce as much turbulence of the charge as is possible and is fitted with a Bosch fuel injection valve, supplied by a Bosch pump. Directly connected with this chamber there is a secondary chamber that increases the compression space by about one-half. The interconnecting passage is provided with a simple screw-down valve that can be used to isolate the secondary chamber, or be retracted away from the heat of the explosions. When the valve is screwed down on to its seating and the second chamber is cut off the combustion space is such that the compression rises to some 600 lb. per square inch, which is sufficient to ignite the charge even when the engine is quite cold. Then, when the engine is running, the valve can be screwed back, opening out the extra space and reducing the running compression to the normal value of 400 lb. per square inch. On this manœuvre being repeated several times at our request, we noticed no abrupt change in the running of the engine and there was no hesitation in the actual start. The operation of screwing back the valve occupies only a few seconds.

The mechanical construction of the engine needs little comment, as it is so plainly shown in the cross-section. It will be observed that the valves are of the overhead type and are operated by gear, which is totally enclosed in order to reduce noise to a minimum. The piston is of aluminium alloy.

These engines are being made in two ranges of sizes, one running at 600 r.p.m. and the other at 1000 r.p.m.



SECTION THROUGH CYLINDER OF LISTER HEAVY-OIL ENGINE

The first range includes a 5 B.H.P. single-cylinder and 10 H.P. and 18 H.P. twin-cylinder sets. The faster engines are of 9, 10 and 36 horse-power, with one, two and four cylinders respectively. It should be pointed out that the stools on which the 9 horse-power engine illustrated stands can be readily detached so that the engine can be bolted down on bearers as close to the keel of the boat as is possible when it is used for marine propulsion.

The Platinum Industry in the Transvaal.

SEVERAL papers dealing with the platinum industry of the Transvaal were submitted to the Empire Mining Congress during its recent session in Johannesburg. "The Metallurgy of Transvaal Platinum Ores" was the subject of an important paper by Mr. F. Wartenweller, A.M. Inst. M.M., consulting metallurgist, Johannesburg Consolidated Investment Company, Ltd., and Mr. A. King, A.R.T.C., A. Inst. M.M., consulting metallurgist, New Consolidated Gold Fields, Ltd. The authors presented a review of the metallurgical position of the Transvaal platinum industry towards the end of 1929. With the discovery of platinum group metals in large deposits in the Transvaal, the recovery of those metals assumed a national and economic importance. At first the metallurgy was curiously taken for granted, an error induced when an analogy was drawn with that of the Russian deposits, in which the metal is in a coarse and unassociated condition. This view was justified to some extent by the nature of the Onverwacht occurrence and by the ready recovery of a portion of the metals in the pioneer discovery at Welgevonden, in both of which it was possible to make a good showing by simply panning. With the development of the sulphide and oxidised ore bodies in the novites it became apparent that metallurgical science would have to play an important, if not the major, part in rendering these deposits of economic value.

The authors dealt with the classification and description of platinum ores, also the treatment processes and plant. The Rustenburg district, they consider, is assuming major importance. On the Waterval (Rustenburg) Platinum Mining Company's property early experimental work on the treatment of oxidised novite ore seemed to show that economical extraction of the platinum metals would be difficult, if not impossible. Most of the experiments had been carried out with the flotation process, and at that time there were doubts regarding a satisfactory commercial method of treating a flotation concentrate containing a few ounces of platinum group metals per ton. During the opening up of this company's mine in the Rustenburg district in the latter half of 1928 further work was undertaken on that class of ore, and it was soon demonstrated that a fair measure of success seemed possible with gravity concentration as the principal method of extraction, particularly as it was found possible to separate a rich and immediately saleable product. Experimental work also showed that additional extraction could be obtained by applying the flotation process to the tailings from gravity concentration. The satisfactory results from experimental gravity concentration of oxidised ore, together with the fact that a considerable tonnage of that ore could be developed and mined cheaply in a short time, were the principal factors in deciding to erect at once the necessary plant. By the end of July, 1929, within twelve months of starting operations, a plant capable of treating by gravity concentration 10,000 tons of oxidised ore monthly was in successful operation.

Dealing with the mine of the Potgietersrust Platinum Company, the authors stated that the ore was a pyroxenite ore, those ores representing at present by far the largest available and potential source of the platinum group metals in the Transvaal. On this property a pilot plant had been in operation for some time on both the oxide, sulphide and mixed pyroxenite ores, and the metamorphosed dolomite contact ore of the company. Beginning with the treatment of an ore carrying palladium as the major platinum group metal, the treatment to-day was on an ore containing platinum in the larger proportion. The Potgietersrust plant started with all recovery in the form of flotation concentrate. With experience, and as the result of experimentation and with changes in ore characteristics, gravity concentration was introduced and further steps in cleaning flotation concentrate. The plant on the Potgietersrust Platinum Company's Rustenburg section was designed particularly to mill and concentrate oxide and sulphide ores. It was explained that, according to the flow plan, the methods used were :—(*a*) Two-stage crushing to approximately ¾in. mesh; (*b*) two-stage ball milling to approximately 95 per cent.—90 mesh; (*c*) gravity concentration in several stages and dressing to produce "crude platinoids" and a rich concentrate; (*d*) flotation concentration of the tailings from gravity concentration; (*e*) the crude platinoids are sent to the refiner and concentrates from (*c*) and (*d*) are treated in a separate plant.

"Crude platinoids" were being produced at every platinum mine in the Transvaal, and both from dunite and pyroxenite ores. At present, beyond cleaning with acids to eliminate base metals and base metal sulphides, which treatment brought their platinum content to the neighbourhood of 50 per cent., no further refining operation was carried out in South Africa. They constituted a product which was being marketed abroad after complete refining in which the metals of the group were separated. Three methods were used in the treatment of concentrates. An amalgamation method, which had already been successful at the Onverwacht Mine, which had now exhausted its ore pipe, converting the platinum metal in dunite ore concentrate to a marketable form. In the second method the concentrate from a sulphide ore was smelted to a matte and then subjected to acid or other treatment in order to obtain the platinum group metals in a concentrated form which could be given over to final refining. Considerable success had been met with, and a total recovery of over 90 per cent. of the group metals had been

obtained. The base metals, copper and nickel, contained in the concentrates were also recovered.

Under the third method a process using chlorine in a heat reaction had been evolved locally. It was called the chlorine process and had been developed at the laboratory and small-scale working plant of Rand Mines, Ltd. The Potgietersrust Company became associated with it, and a working plant was now in operation at the Government Gold Mining Areas property on the East Rand. The recovery obtained in the small working scale plant was 90 per cent. of the platinum and slightly less of the palladium. The copper and nickel extraction was in the neighbourhood of 70 per cent., depending on the character of concentrate treated. The final platinum product produced contained 50 per cent. of the group metals. The process was suited to concentrates either from oxidised or sulphide ore.

Canadian Engineering News.

(From our own Correspondent.)

Rapid Progress of Civil Aviation.

Statistics regarding civil aviation in Canada, prepared by the Department of National Defence, show that well over 6,000,000 miles were flown by aircraft in civil flying last year. Aeroplane mileage, exclusive of the mileage flown by seaplanes and amphibians, increased by 161 per cent. over the previous year. The year 1929, when compared with 1927, showed the huge increase of 1848 per cent. The percentage increase is not quite so large when seaplanes and amphibians are included. For all aircraft the increase in 1929 over 1928 was 133 per cent. Compared with 1927, the total mileage last year increased by 658 per cent.

The figures show that only 209,583 miles were flown by aeroplanes in 1927, against 1,557,917 miles in 1928, while for 1929 the distance covered by the land craft had increased to 4,083,321 miles. Float seaplane mileage shows a similar large increase from 247,238 miles in 1927 to 797,998 miles in 1928, and 1,768,738 miles in 1929. The total aircraft mileage for all types of machines was 6,284,079 in 1929, as against 2,728,414 in 1928 and 829,010 miles in 1927. The number of hours flown by aircraft rose from 12,070 in 1927, to 43,071 in 1928 and 79,786 in 1929.

Mineral Production.

Coal production in Canada has been declining since the beginning of the current year and, because of further displacement of the fuel by oil and the fact that rail freight traffic is lighter than usual, it promises, at least for the present, to continue on a smaller scale. There are, however, satisfactory features in respect of copper production. Only a drastic decline in price would adversely affect the output of Canadian copper ; at present a programme of curtailment is in force in British Columbia, but it is overshadowed by large additions being made to the productive capacity in Manitoba, Quebec, and Ontario. There has been a slight decline in lead, which may continue until development work on a few new properties is completed. An increase in zinc is due largely to a higher content of that metal in the ore mined by the principal producer, as well as to an increase in this company's refining facilities. In view of the severe depression in the zinc market it seems doubtful whether the entire output of the Canadian product has found a market, but most of it comes from a district which is regarded as one of the best situated for continued operations under existing conditions.

The Flavelle Medal.

This year's Flavelle Medal, awarded by the Royal Society of Canada for conspicuous achievements in science, goes to Dr. A. B. Macallum, of London, Ontario, until recently Professor of Bio-Chemistry at McGill University. Dr. Macallum was President of the Royal Society of Canada, 1916–17, and Administrative Chairman of the Advisory Council for Scientific and Industrial Research of Canada, 1917–20. He is a Fellow of the Royal Society of London and holds degrees from Dublin, Yale, Toronto, Aberdeen, and McGill universities.

Amulet Mine Comes into Production.

The new mill of the Amulet Mines, Ltd., went into operation on April 7th. The starting up of the concentrator brings the Amulet property into active production and makes the third important producing mine to become established in the Rouyn district of Quebec, the output heretofore coming from the Horne Mine of Noranda Mines, Ltd., and the Waite-Ackerman-Montgomery Mine, the latter also controlled by Noranda. A branch line of railway was built into the Amulet property last autumn and the construction of the concentrator, begun in September, was carried through to completion in very creditable time. Copper and zinc concentrates are being produced. The former will go to the Noranda smelter for treatment, while, pending the construction of a zinc plant in Eastern Canada, it is expected that an export market will be sought for the zinc concentrates. The Amulet mill, according to its rated capacity, will handle 250 tons of ore per day.

Copper Refinery in Montreal.

Noranda Mines will start construction immediately of a copper refinery in Montreal East, which will cost in the neighbourhood of 3,500,000 dollars. The refinery will be built jointly with the British Metals Corporation, Ltd., of London, England, and the Nichols Copper Company of New York. Speaking of Noranda's, operations recently, the president, J. Y. Murdoch, stated that it was not planned to install any increase in smelter capacity during the current year, but that the capacity of the concentrator was being increased from 500 tons per day to 1000 tons per day. This extension is now under cover and machinery is being installed. Operations in the extension are expected to commence by August. The company's smelter is now nearing the production rate of 1,000,000 lb. of copper per annum.

Canadian National Railway Improvements.

At its Point St. Charles Yards, near Montreal, the Canadian National Railway is carrying out a five-year construction programme embracing improvements in the locomotive, the power-house, the cast iron foundry, and in the repair, machine, freight and passenger shops. The power-house was completed about the end of 1928 ; last year the new locomotive shop was put in commission ; this year a grey iron foundry, a material storage midway with overhead craning facilities and a light repair shop are contemplated. In 1931 the construction of a new passenger shop is to be undertaken, and a large machine shop and wood mill for car repairs is scheduled for 1932 ; while a freight car shop will wind up the programme in 1933.

Proposal to Conserve Natural Gas.

The Canadian Western Natural Gas, Light, Heat and Power Company is preparing plans for an experiment which, if successful, will provide a means to conserve the tremendous quantities of gas now being wasted in the Turner Valley. During the last year or so geologists and engineers have devoted much time in their efforts to find some solution to this problem, which, in view of the increasing waste, has become vital. More than 150,000,000 cubic feet of gas is burned in Turner Valley every day, that volume representing the surplus over and above that used by Calgary and surrounding municipalities in the province of Alberta, which are heated almost entirely with this gas. Every new well brought into production adds several millions to this number. The company is installing a pipe line from Turner Valley to the Bow Island field, and a pump is being installed to force the gas down into the limestone at rock pressure of 750 lb. per square inch at the Bow Island field.

The gas wasted at Turner Valley is that from which the crude naphtha, which is the chief product of the valley, has been extracted by condensing it in a separator. After the naphtha has been separated the gas is burned in the valley, with the exception of a comparatively small amount delivered to the Royalite scrubbing plant to be "washed" before being sold for consumption. Since the amount of gas produced is many times the amount consumed, the measure of success attending the gas company's experiment will be watched with keen interest.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Restricted Demand.

DEPRESSION continuing in many of the manufacturing trades in the Midlands and Staffordshire, the demand for iron and steel and other engineering materials remains of a restricted nature. Business is slow in practically all branches of industry in this area, and though there are indications of improvement in some directions, they are admittedly "slight." Little interest was taken in the weekly meeting of the iron trade in Birmingham this week, there being few buyers in attendance. Many of the manufacturers on 'Change, however, expressed the belief that the next few weeks will see some definite improvement in industry generally.

Raw Iron Price Battle.

The fight for lower prices in the pig iron market is maintained, consumers restricting their purchases to the minimum and furnacemen blankly refusing to discuss altered selling rates. The situation is becoming somewhat strained, and business is at a very low ebb. There is no alteration in the situation from that existing last week, as recorded in this letter, but the position is being anxiously watched by all interested parties. There are consumers here who cling to the hope of an early revision of pig iron prices, and who maintain that the campaign of "holding off the market" will meet with success. Smelters are reluctant to discuss the situation. They express no concern as to present output or as to their ability to keep control of the market. Furnace coke continues in plentiful supply and values are easy.

Steel.

No new momentum has developed in the heavy steel trade in the Midlands, and steelmasters are unsatisfactorily placed for orders. Works are making a regular output against existing contracts, but specifications coming in from constructional engineers are much below par. The Steel Association maintains prices at £8 7s. 6d. for angles, £8 10s. for joists, and £8 17s. 6d. for ship, bridge, and tank plates of ¾in. and over, subject, of course, to the rebate when firms agree to confine their orders to British steel. The volume of work at Midland constructional engineering yards is comparatively small, and constructional engineers are postponing the buying of steel until it is actually wanted. Some good orders have been received for special steels for the automobile industry, but demand in this branch has not developed as well or as rapidly as was anticipated at the beginning of the year. There is no change of note in the half-products department of the steel trade. English billet makers are badly off for orders, and reports are current of stocks being liquidated in special cases at rates below those generally quoted. Continental prices are on the basis of £5 12s. for 2in. billets and £6 8s. 6d. for small steel bars delivered in this district, these being minimum rates fixed by the continental cartel. Sellers of English bars want about £8 upwards.

Finished Iron.

Demand for Staffordshire marked bars is maintained. Orders come in steadily, and makers experience no difficulty in getting £12 10s. per ton for their output. Unsatisfactory conditions continue in the Crown bar and common bar departments of the market. Internal and continental competition are as keen as ever, and Staffordshire ironmasters have the greatest difficulty in securing orders. They certainly win when quality is of importance, but that qualification seems to be becoming a rarity. Price seems to count more than quality these days. Staffordshire Crown bars are quoted by most makers £10 7s. 6d. per ton. Makers from other districts are prepared to do business at below £10, so that there is a considerable margin in their favour. Staffordshire producers of common bars for the nut and bolt and fencing trade are poorly off for orders. Sellers of No. 3 Belgian iron are securing a greater portion of the small amount of business coming on to the market. There is, at date, a very depressed air about this section of the Staffordshire iron trade. Ironmasters who are re-rolling steel, having adapted their plant for this purpose, are meeting with a fair amount of success in competition with the steel mills. They are hardly so well employed, however, as they were a few months ago. There is no change in the iron strip branch of the market, moderate tonnages being disposed of at £11 2s. 6d. per ton.

Galvanised Sheets.

Midland galvanised sheet mills continue to quote a minimum price of £11 17s. 6d. per ton for 24 gauge galvanised corrugated sheets, though they are in many cases very short of orders, and have difficulty in keeping plant in operation. Sheet makers in general doubt if any lowering of prices would give an added impetus to trade. Consumptive demand in all markets appears to be at a low ebb, while there are special difficulties attaching to business with such markets as India and Australia just now. Millowners continue to hope for an improvement in the near future.

Scrap.

There is no evidence of an improvement in the steel scrap market. This week Birmingham merchants have received from South Wales offers of small-scale business in heavy steel scrap at £3 per ton delivered, but these offers have been turned down, £3 2s. 6d. being considered the irreducible minimum. Indeed, most sellers refuse to do business at below £3 5s. Many of the consuming works are working only three days a week, and are in no need of fresh supplies, present stocks being ample for some time to come at the present rate of consumption.

Trade Returns.

The trade returns issued by the Board of Trade with reference to the month of April are discouraging, and Midland and Staffordshire industrialists are becoming dejected. The break in business, owing to the Easter holidays, undoubtedly accounted to some extent for the poor showing, but it can hardly be held responsible for a fall in the value of exports of articles wholly or mainly manufactured, when compared with April last year, of £10,449,072. There was a fall in exports of iron and steel and manufactures thereof of £1,023,403, in the vehicles group of £905,369, and in non-ferrous metals and manufactures of £556,903. Imports were also down considerably last month, imports of raw materials being less by £10,237,862, and manufactured goods less by £4,540,389. Iron and steel imports were down by £409,760, non-ferrous metals and manufactures by £506,092, and vehicles by £396,502. Taking the four months of this year, exports of iron and steel have declined in value by £2,971,947, while ingots have increased in value by £1,243,551. The tonnage of iron and steel imported in April was 234,806 and for the year to date 1,084,810 tons.

Automobile Engineering.

Neither in Coventry nor in Wolverhampton is the automobile engineering industry as busy as it is normally at this time of the year. The outlook is reported to be becoming brighter each week, but the recovery from the setback previous to the Budget is slow. Current business, though including a fair amount for overseas, is chiefly for the home market, and the call for popular light cars increases out of proportion to that for other classes of vehicles. Makers of motor car accessories in the Midlands are moderately employed, and firms making petrol tanks and pumps report order books so well filled as to ensure regular work right through the summer months.

Severn Bridge Widening.

The Worcester City Council proposes to widen the Severn Bridge at Worcester, at a cost of £44,664, and, subject to the contribution of 75 per cent. of the outlay by the Ministry of Transport, the scheme has been approved. The Council is recommended by its Committee to accept the tender of the Yorkshire Hennebique Contracting Company, Ltd., of Leeds, to carry out the work at the figure stated above.

Unemployment.

Any decline in unemployment is welcomed as denoting improving trade, and this week I am able to record a fall of 2872 in the number of unemployed persons in the Midlands. The reduction is spread over most of the towns in the area, the exceptions, where increases have occurred, being Birmingham, Coventry, Leicester, Nottingham and Redditch. The position remains very serious, however, there being no fewer than 236,247 workless hands in the Midlands, of whom 157,276 are men, 67,811 women, 4881 boys, and 6279 girls.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Rationalisation not a Cure-all.

COMMENTS on the rationalisation talk, which has been a feature of the textile machinery industry during the past twelve months or so, were made by Sir George

Bullough at the annual meeting of Howard and Bullough, Ltd., Accrington. Further serious consideration, he said, had been given to the question of amalgamation or regulation of selling prices by the various machine makers, and meetings and consultations had taken place, but so far without tangible results. "It must, however, be borne in mind that no schemes of rationalisation or combinations on the part of machine makers can furnish a remedy for the lack of the demand in the trade, which, after all, remains the dominant factor." The speaker pointed out that whilst there was a great scarcity of orders for new textile machinery, the company was endeavouring to develop its trade further in the supply of renewals and the replacement of machinery parts, and was constantly keeping in view any avenues of work in any other line for which the company's equipment was suitable. Reviewing current trading conditions in the textile machinery branch of engineering, Sir George stated that orders were difficult to obtain in the home and also in most of the continental markets. The firm, however, had orders in hand for Australia, and other business was pending for that country, whilst in India, China and Japan there was a fair amount of activity at the present time.

Balance Sheets.

Although in its case the decline has been less pronounced than in a number of others, the balance-sheet of Tweedales and Smalley, Ltd., of Castleton, Rochdale in common with the majority of Lancashire textile machinery makers, discloses a smaller profit than in the previous year, and for the first time the holders of the ordinary shares are to receive a total dividend for the year of less than 15 per cent., the distribution for the past twelve months, including the interim dividend of 7½ per cent. paid last October, being one of 10 per cent. The available balance, including the sum of £87,300 brought forward, would have been sufficient to have paid the dividend at the usual rate, but owing to the general uncertain outlook the directors deem it prudent to conserve the company's cash resources. The net profit for the past year amounted to £56,671, compared with £70,179 in the previous year, and £77,331 in 1927–28. An appreciably improved showing is made by Bell Brothers (Manchester, 1927), Ltd., filtration engineers, of the Calder Ironworks. A trading profit of £17,257 compares with a loss of £15,662 for the fifteen months' period preceding. The directors report that although trading conditions have been difficult, with competition exceedingly keen, the amount of work completed constitutes a record.

Manchester's Underground Scheme.

The underground railway scheme for Manchester, which has been prominently discussed during the past year or two, is, according to Councillor T. Walker, who is chairman of the Corporation Underground Railway Committee, proceeding satisfactorily, and he hopes before long to be able to announce that certain negotiations which have been in progress for some time have been successful.

Non-ferrous Metals.

In marked contrast to the experience of the past few weeks, there has been a pronounced recovery in all sections of the non-ferrous metals market since my last report. The extremely low levels then current for all the metals have attracted a good deal of interest, much of it of a speculative character, and this influence was most noticeable in the early days of the present week, when appreciably higher prices all round were demanded. Relatively and actually the recovery at the time of writing is most noticeable in the copper section, in which the rise in standard brands, both for cash and forward metal, has been little short of £10 per ton, bringing quotations higher than since the middle of April. The recovery in the case of tin has been on a smaller scale, although here, also, more than half of the previous week's drop of £14 per ton has been made good. Lead is now back to the level of a month ago and a marked recovery has likewise to be recorded in respect of spelter. There is more than a possibility of reaction setting in when the "bullish" influence of the buying spurt has exhausted itself, and it would be unwise to predict that the bottom of the market has now been definitely left behind.

Iron and Steel.

The Lancashire iron and steel markets, almost without exception, are in a dull condition, and although in some quarters a somewhat less depressed view of the position is being taken, the outlook at the moment is the reverse of inspiring. Lack of confidence in price stability and unsatisfactory order books combine to restrict purchases of raw material by local foundries. Few of them have much on the books of pig iron makers against which to draw for deliveries, and in virtually every instance new commitments cover only the next few weeks. Values are steady at 77s. per ton for Staffordshire and Derbyshire makes, about 95s. for Scottish and 91s. for West Coast hematite, all delivered equal to Manchester. The last-named has eased off a little and prices have been reduced by about 1s. a ton. Not much business is passing in bar iron, quotations for which are at £10 15s. per ton for Crown quality bars and £9 15s. for seconds. In steel, the most disappointing feature so far as bulk business is concerned, is the continued poor call for material by Lancashire constructional engineers, the position of whom shows little indication of improvement. The situation is somewhat more satisfactory in the locomotive engineering branch, and deliveries of plates in that direction are maintained on a fair scale. Bars of all kinds and also general plates are, however, attracting only very moderate attention, and early deliveries are easily obtainable. Prices of home-produced steels show little alteration on balance, but the steadiness of imported materials is more apparent than real.

BARROW-IN-FURNESS.

Hematite.

Weak spots are developing in the West Coast hematite pig iron market, which is evidenced by the cutting of prices. This reduction goes very much against the grain, for in many cases it means sacrifice of profit, whilst in others it leaves no margin. A thinner demand and keenness of competition from other districts are responsible for the fall. Customers are less inclined to place orders for forward delivery and contracts held cover the next three months or so. If, when those contracts are completed fresh orders do not come along, reduction of output will have to be faced. The steel departments require iron, and this fact is helping to sustain the demand for output on the present scale. The Continent continues to take deliveries of iron, mostly of stated analysis, and more American business is possible. Iron ore is about the same. The outside trade is being maintained, but no more. The steel market is not bright. Workington is still engaged and the Barrow mills started this week on contracts which will keep them going for a few weeks.

Shipbuilding.

The tender for the new Cunard liner went in on Monday from Barrow, and locally there is much excitement as to the ultimate destination of this big contract.

SHEFFIELD.

(From our own Correspondent.)

Figures of Steel Production.

THE latest figures of steel production for this district, issued by the National Federation of Iron and Steel Manufacturers, are more cheering than might have been expected. They are, however, for the month of March, and it is very doubtful, to say the least, whether they represent the position of the following month. They show that both Sheffield and Lincolnshire recorded an increase on the comparative returns. In Sheffield the output in March was 112,600 tons, as against 102,100 tons in February and 110,200 tons in March of last year. The total included 50,800 tons of acid steel and 53,300 tons of basic. For Lincolnshire, the most recent figure was 76,600 tons, compared with 68,400 tons in the previous month and with 61,000 tons in March, 1929. Lincolnshire's production was almost entirely basic steel, and the area also turned out in March last 72,700 tons of basic pig iron.

The Present Position.

Since March the production has fallen away to a considerable extent, especially in the Sheffield area, where several furnaces have had to be closed. The position shows no signs of mending. The orders coming to hand are, for the most part, for small quantities. There is a lamentable scarcity of bulk bookings, and, to make the matter worse, inquiries are so poor that they afford no indication of a revival in buying. Taking as a whole the demand for ordinary commercial steels such as Sheffield produces, there is agreement in the trade that conditions now are worse than they have been for many years. This situation is largely due to depression in overseas markets, from practically all of which bookings show a serious decline. In North Lincolnshire, also, there has been a general decline of activity. With regard to the Frodingham works, it is hoped that the closing of the melting department, announced last week, may only be a matter of a few weeks, and repairs are now in hand at the furnaces. For a long period output has exceeded mill consumption, and 10,000 tons of ingots and billets have accumulated. Owing to scarcity of orders, it has also been necessary to curtail production of steel plates at the Appleby works, but that also is regarded as but a temporary measure.

Departmental News.

On the heavy manufacturing side, there is a good deal of work in progress in special steel forgings, particularly for hollow forged boiler drums. The British railway companies are sending in a fair flow of orders for axles, tires, and springs, their requirements being rather above those of last year. There is, however, a great scarcity of work from overseas, while wagon builders are so short of orders from private owners that their demands for these supplies are severely restricted. A rather better inquiry is reported for alloy and other quality steels. The special departments are much below their best records. I have been able for a long time to report well-sustained progress in the demand for steels of the stainless and non-corrodible varieties, makers of which have been kept very busy. Now, however, they are not by any means so active, and the combined production, though still very large, is probably not equal to that of last year. There has been an increase in the number of local firms engaged in this trade, and prices have come down, while competition has sprung up in several countries on the Continent. There is a moderate amount of work on hand in forgings for commercial motor cars, which is of value to several firms, but the demands of the makers of touring cars are below the level to which Sheffield has been accustomed for some time. A few firms are meeting a moderate call for cold wrought steel and strip. For best tools, twist drills, and hack-saws, the call is fairly good. The saw and file trades could do with a great deal more work. There has been a change in the proprietorship of the old-established firm of Taylor Brothers (Saws), Ltd., Adelaide Works, Sheffield, and Mr. John H. Barker, who has been actively associated with the staple industries of the city for more than thirty years, has been appointed governing director.

A Derby Development.

The firm of Qualcast, Ltd., of Derby, which manufactures lawn mowers and light repetition iron castings, is taking the enterprising step of establishing a works in Australia, near Melbourne. A separate subsidiary company is to be formed, which will start with the manufacture of lawn mowers, and will later take up other goods, such as those made at Derby. Captain R. A. Briggs, of the Derby staff, will go out to Melbourne as managing director.

Mr. Baldwin's Visit.

Mr. Stanley Baldwin's choice of Sheffield as the centre in which he initiated his Home and Empire campaign last week was of more than ordinary interest. He came to expound his Party's policy with regard to trade, to a city which needs a stimulus as much as any, and it may be said that, altogether apart from party politics, his proposals were such as commended themselves to the majority of those who are concerned with the restoration of the city's industrial prosperity. His main theme was the necessity for safeguarding the iron and steel industry, a step which is advocated by the Sheffield Chamber of Commerce, and by many of the city's industrial leaders. They could not rationalise the industry without safeguarding, said Mr. Baldwin. He also announced that there was not a single duty which the Chancellor of the Exchequer was taking off which the Conservatives would not have the greatest pleasure in putting on again the moment they returned to power. That was good news, incidentally, to the cutlery trade, which ineffectually appealed to the Chancellor, shortly before the Budget speech, to keep in force the safeguarding duty which it at present enjoys, but which is to be allowed to lapse in December. Mr. Walter Dodgson, of Sheffield, divisional secretary of the Iron and Steel Trades Confederation, has since declared himself personally in agreement with Mr. Baldwin on the question of safeguarding, though he is not in a position to speak on behalf of the executive of the Federation, which has not made a pronouncement on the question.

A New Market Hall.

Municipal developments in Sheffield continue, and with them schemes for the rebuilding of the centre of the city. The latest enterprise is the removal of the fish and game market from the Fitzalan Market Hall, which it has occupied for about a century, to new quarters. The Fitzalan Market occupies a valuable site in the very centre of the city, and the old building is now being demolished to make way for new shops. A considerable part of the site has already been leased. The new market is only a short distance away, and is called the Castle Hill Market, from the fact that it occupies part of the site of the historic Sheffield Castle—which was founded in the twelfth century and disappeared in the Cromwellian period—relics of which have been found during the building operations. The site of the new building covers about 1 acre, and the work of erection has been carried out, at a cost of £47,000, by the Direct Labour Department of the Corporation to the designs of the City Architect, Mr. W. G. Davies. The main market measures 209ft. by 145ft. Forty-five shops, mainly occupied by butchers, are arranged around the external walls, and in the centre are fifty-six stalls for the sale of fish, fruit, vegetables, and flowers. All the shops are fitted with electric light and power, and the equipment of the butchers' shops includes rails of stainless steel.

Conserving Water Resources.

The question of conserving the water resources of Yorkshire is receiving much attention from public bodies just now, and Sheffield is playing a leading part in the schemes that are being drawn up. A Regional Advisory Water Committee for the West Riding was appointed at a conference held in Leeds, at which the Minister of Health was present, and 155 local authorities and four joint water boards were represented. The South Yorkshire Regional Committee has appointed a technical sub-committee, consisting of managers of waterworks undertakings, to investigate the whole question of water supply in its area. Of this sub-committee Mr. W. Terrey, general manager of the Sheffield Waterworks Department, has been elected Chairman. The sub-committee has also agreed, on Mr. Terrey's suggestion, to begin its work by circulating a detailed questionnaire, with the object of ascertaining exactly what is the present position of the resources and what are the possible supplies which may be available in the future.

Mine Surveyors.

Professor I. C. F. Statham, Professor of Mining in the University of Sheffield, has been elected President of the Institute of Mine Surveyors.

An Increased Profit.

Thos. Firth and Sons, Ltd., the well-known steel manufacturers and pioneers of stainless steel, has just issued its annual report, which is the first to be published. It is a very satisfactory document, showing a profit for the year ended December 31st last of £126,090, out of which the directors recommend a dividend of 6½ per cent., less tax, on the ordinary shares, which are privately held. The carry forward is £119,081. The directors state that the progress of the company is reflected in the enhanced profit, and the demand for its specialities is an increasing one.

NORTH OF ENGLAND.

(From our own Correspondent.)

Praise for North-East Coast Industry.

THE Visitation Committee of Lloyd's Register completed this week an extensive inspection of the shipbuilding, engineering and steel-making establishments on the North-East Coast. The members, in their main conclusions, were impressed with the numerous and important improvements which have been carried out in many of the establishments, and were gratified to find that the quality of the work which they inspected was up to the high standard of excellence for which the district was famous. They were, however, depressed at the prospect for the immediate future in the shipbuilding and allied industries, which is far from rosy, notwithstanding that many establishments are carrying on with little hope of adequate profit and, in some cases, even at a loss. In its tour, the Committee learned that shipbuilders and engineers are concerned at the fact that while there is a fair amount of work in hand in some shops, there is a general lack of inquiries from shipowners, and a great shortage of orders for new tonnage. Competition from foreign builders has extended within the last few years and become much more intensive, thus adding very considerably to the difficulties of British builders.

More Furnaces Put Out of Operation.

Unsatisfactory and discouraging accounts continue to be given of the various branches of iron and steel industry. In most departments orders are urgently needed to follow on fast-expiring contracts. The decision of the Palmer Shipbuilding and Iron Company, Ltd., to damp down its two blast-furnaces at Jarrow, one of which has been running on Cleveland pig iron and the other on hematite iron, following the blowing out of three blast-furnaces by the Linthorpe-Dinsdale Smelting Company, Ltd., brings down the number in operation on the North-East Coast to 34 out of 93 erected. Since the beginning of the year eight blast-furnaces have been blown out.

Cleveland Iron Trade.

The Cleveland pig iron trade is without new feature. The drastic reduction in output is a wholly salutary policy. The industry of late has been suffering from all the evils of over-production, and although, unfortunately, many works will be laid idle, the elimination of redundant plant will help to stabilise the trade of the district. Transactions have shrunk to very small proportions on home account, and there is very little export business passing. Prices, however, are maintained, No. 1 foundry being 70s., No. 3 G.M.B. 67s. 6d., No. 4 foundry 66s. 6d., and No. 4 forge 66s.

Hematite Pig Iron.

East Coast hematite pig iron producers are inclined to take a slightly firmer stand following substantial curtailment of make, but output is still excessive and sellers are hampered by heavy stocks. Merchants hold substantial quantities and continue to undersell manufacturers. The latter offer iron at the equivalent of ordinary qualities at 74s., which is several shillings below cost. No. 1 quality is at a premium of 6d. per ton.

Ironmaking Materials.

There is no market for imported ore. Consumers hold large stocks, and have big deliveries to take under running contracts. Best Rubio ore is nominal at 21s. c.i.f. Tees. Blast-furnace coke is plentiful, and consumers are not disposed to negotiate for supplies. Durham good medium qualities are obtainable at 17s. 6d. delivered at North-East Coast works.

Manufactured Iron and Steel.

The manufactured iron and steel trade is very slack. Orders are urgently needed and must come soon if stoppages are to be averted. Production has, in fact, already been reduced. Prices are unaltered.

The Coal Trade.

The general condition of the northern coal market is little altered, but in sections it shows more activity. The collieries are likely to work fairly regularly during the next week or two because of a shade stronger inquiry in all classes of coal for early delivery. For more forward dates of shipment the position is irregular, but sellers of steam coals hold to recent values as the rock bottom minimum. Best Northumberland steams command 13s. 6d. direct, and only odd coppers are discounted by contractors. Best Durham steams are well situated with prompt orders and are firm at 15s. 9d. for large and 12s. 9d. for small. Tyne prices and similar are quietly steady at 12s. 9d. For Northumberland smalls the situation varies according to individual owners' position, but Durhams are nominally steady at 10s. 6d. to 11s., and good ordinary class at 10s. There is a sustained demand for coking unscreened and an increasing inquiry for best quality bunker coal, and, although the production can be readily increased, fitters and other holders ask a steady range of prices. Best bunker coals are in particular much brighter, and easily command 14s. 9d. Secondary Durham unscreened are steady at 13s. 6d. to 13s. 9d. Steamers are now preparing to leave for the Russian timber trade, and this month and next the North-East Coast ports will probably supply 60, a good many of which have been laid up in the Tyne and neighbouring rivers. Durham coking unscreened are moving in good average volume at 13s. 6d. to 14s., and discounts are difficult to enforce. For gas coal the position is quiet and the outlook none too bright. Best kinds are at 15s., secondary qualities at 13s. 6d., and prime Durham at 16s. 3d. to 16s. 6d. There is a very brisk demand for gas coke, and makers are pressed to give early delivery. Prices are, consequently, firm for any overseas trade at 21s. 6d. For patent oven coke the position is quiet, and operators are generally marking time owing to the formation of the Cartel amongst Scandinavian shippers. For other trades the demand is slow, and sellers press large stocks on the market at 18s. Beehive coke is in slow demand at 26s. to 30s.

SCOTLAND.

(From our own Correspondent.)

Dull Outlook.

If the ruling conditions in the shipbuilding industry and in the steel, iron and coal trades may be taken as a guide, the trade prospects over the next few months can only be characterised as dull. Buying generally is on a meagre scale, and there is an all-round scarcity of specifications for all classes of material. There are rumours of further developments in the nature of rationalisation arrangements in the heavy trades, but some time may elapse before definite steps are taken.

Steel.

At the moment there is a decided scarcity of business in plates and sectional material, and the production is of necessity curtailed. Sheet makers have a moderate amount of business on hand, but the turnover is chiefly confined to the lighter descriptions. Heavy sheets suffer in competition with the lighter material produced by steel makers. Galvanised sheets are very slack meantime. An improvement is noted in the tube trade, although there is still room for expansion in the demand for lap-welded and butt-welded sorts. Employment at the tube works producing small diameter tubes is irregular.

Iron.

Short time is the rule at the works engaged in the production of bar iron and re-rolled steel. Prices are unchanged, with the latter quoted at £7 12s. 6d. per ton home or export. Only twenty-seven pig iron furnaces are in blast in Scotland, but the output is sufficient for all demands. Fair quantities of pig iron continue to arrive in this district from India and the Continent. Last week a cargo amounting to 2500 tons arrived from Calcutta, and there was also a cargo of 1650 tons from England.

Scrap.

There has been a moderate demand for scrap, with prices showing an easier level, 67s. 6d. for cast iron machinery, 60s. for heavy steel, and about 61s. for heavy basic.

Coal.

There has been little, if any, improvement in the export demand, and this fact, along with a decline in home requirements, has produced a state of depression in the coal industry. Continental producers are keen competitors in foreign markets, and exporters here are finding great difficulty in securing prompt orders. Forward transactions are especially difficult to arrange, as probable changes in the industry have to be allowed for, which generally means a prohibitive price. Practically all descriptions of fuel are in need of business, and in all districts broken time is prevalent. The exception to the rule is provided by first-class Fifeshire steams, which are readily absorbed. Prices as a rule are nominally unchanged, though nuts show a slight increase, due to a scarcity of supplies and not to any increase in turnover. Aggregate shipments for the past week amounted to 254,043 tons, against 258,460 tons in the preceding week and 233,502 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade.

It cannot be denied that the conditions in the steam coal trade and to a lesser extent in the anthracite section are very discouraging, and the atmosphere in business circles is depressing. Business is undoubtedly bad, so much so that it is almost inconceivable that it could be worse. Much uncertainty prevails as the result of the Mines Bill, the threat of trouble over working hours at the docks and the scarcity of orders from abroad. Few collieries have been working with anything like regularity, and the prospects are not good. It is estimated that a million and a half tons of coal are standing on the sidings, owing to the fact that there is not a ready outlet for the coals. This means, of course, a shortage of rolling stock to enable collieries to work. At the end of last week there were thirty-nine idle tipping appliances at the various docks, and this week the conditions in this respect are not much improved, as on Monday there were thirty idle tips and on Tuesday the number was twenty-eight, while only two steamers were waiting to load. The returns of shipments last week, as issued by the Great Western Railway Company, afforded no satisfaction, as the total only came to 492,400 tons, which was less by just over 102,000 tons than in the preceding week and over 32,000 tons less than for the corresponding period of last year. The comparative paucity of orders means that outward chartering is restricted and it cannot be pretended for a moment that the immediate outlook is bright. The fact that so much tonnage is laid up is reacting very adversely upon collieries, as the consumption of bunker coals abroad results in considerably reduced shipments to the foreign coaling stations. Outward rates of freight, except in the short trades, have certainly recovered to some extent, but as against this homeward business is very unsatisfactory, and there is not much advantage accruing to the shipowner. It will thus be seen that both collieries and the shipping industry are passing through a very bad time. So far as coals are concerned, the only interest of late has been in the contract for the supply of coals to the Egyptian State Railways. The last steamer has recently been chartered to load under the old contract for 16,5000 metric tons, and the new contract for the delivery of 250,000 metric tons of Welsh coals at Alexandria over a period of five months has started. The report from Cairo that this order had been split up between three local firms turns out not to be correct. It is understood that the Maris Export and Trading Company has secured the whole of the order at the price of 26s. 5½d. per metric ton c.i.f. Alexandria, and that the usual Monmouthshire collieries which have supplied coals in the past will not have the benefit of the business.

The Mines Bill.

There is no doubt now that grave fears are entertained in this district that South Wales will suffer more than any other if the Mines Bill comes into operation in its present form. The Chambers of Commerce in this area and other bodies interested in the export of Welsh coals are moving in the matter, and endeavouring to get the Government to compromise in respect of the application of the working hours clause, as the operations of a rigid seven and a half hours day will increase the cost of production to such an extent as to make it increasingly difficult for Welsh coals to compete for the restricted amount of business available. The seriousness of the position has induced the Coalowners' Association to issue a further statement regarding the proceedings a week ago, when the coalowners met the miners' representatives on the Coal Conciliation Board with regard to the new coalfield agreement. It is emphasised that if the Mines Bill goes through in its present form then changes of a drastic character will have to come about if this district is to maintain its ability to work.

Coal Shipment Hours.

Coal trimmers and tippers were balloted on Monday and Tuesday of this week regarding the proposal to do away with night work and to revert to the old system of two continuous day shifts. Business men are not feeling at all easy about the matter, as any strong action on the part of the men to enforce their wishes will undoubtedly be stoutly resisted. The coal trimmers and tippers were asked definitely on their ballot papers whether they are in favour of strike action in order to obtain their desires, so it looks as if the matter is being taken very seriously by the men's leaders. The result of the ballot is awaited with very considerable interest.

Tin-plate Industry.

At the end of last week delegates attended the annual conference of the tin-plate section of the Western Division of the Iron and Steel Trades Confederation, when the question of payment of wages during the annual holiday week in August was discussed. It was pointed out that the matter was still before the employers, and although according to them the cost would be equivalent to £81,000, yet similar concessions had been made in other industries. The conference unanimously decided to press for the payment of wages during the holiday week, while a further resolution complained of the policy of increasing the productive capacity of the trade by the erection of additional mills when the current demand was being met by less than 80 per cent. of the existing capacity.

Current Business.

There has been no alteration in the general tone of the steam coal market. The conditions in respect of practically all classes of coal are quiet, although smalls are relatively scarcer owing to the restricted production of large coals, as a result of so many stoppages of work at the pits. Prices all round are on the minimum levels. Patent fuel and coke are steady, but not in active demand, while pitwood has weakened owing to the diminished demand for supplies, the price being about 26s. to 26s. 3d.

CATALOGUES.

British Jeffrey-Diamond, Ltd., Stennard Works, Wakefield.—A pamphlet on air break circuit breakers.

British Insulated Cables, Ltd., Prescot, Lancs.—Publication 253 on copper and aluminium sheets and sections.

Marshall, Sons and Co., Ltd., Gainsborough.—"Marshall Machinery for Preparing and Handling Stone, Sand and Gravel."

Delco-Remy and Hyatt, Ltd., 111, Grosvenor-road, S.W. 1.—A brochure describing the "Binks" paint spraying equipment.

David Bridge and Co., Ltd., Castleton, Manchester.—Bulletin No. 124 of the "Bridge-Banbury" automatic rubber mixer.

Asea Electric, Ltd., 5, Chancery-lane, W.C. 2.—List No. A33 of single-phase, polyphase and direct-current "Century" motors.

Charles Churchill and Co., Ltd., 9–15, Leonard-street, E.C. 2.—Catalogue No. 88 of the "Reeves" variable-speed transmission.

Bakelite, Ltd., 68, Victoria-street, S.W. 1.—A brochure describing "Bakelite" laminated gear material for silent gears and pinions.

W. H. A. Robertson and Co., Ltd., Lynton Works, Bedford.—"The Development of 'Robertson' Cold Rolling Mills for Strip Metal."

Crompton Parkinson, Ltd., Guiseley, Leeds.—Specification No. A 410 of current transformers; No. A 500 on direct-current switchboards.

Northwest Engineering Company, 28, East Jackson Boulevard, Chicago, Ill., U.S.A.—A pamphlet, "Ground Pressure Data."

Cambridge Instrument Company, Ltd., 45, Grosvenor-place, S.W. 1.—List No. 108, dealing with instruments for hydrogen-ion measurements.

Tangyes Ltd., Cornwall Works, Birmingham.—Catalogue No. 382, giving particulars and illustrations of low-compression cold-starting heavy-oil engines.

Head, Wrightson and Co., Ltd., Thornaby-on-Tees.—A pamphlet illustrating some of the types of steel railway wagons and fittings supplied by the firm.

Robert Jenkins and Co., Ltd., Rotherham.—A booklet illustrating a variety of welded tanks and vessels made by the firm for all branches of industry.

Staveley Coal and Iron Company, Ltd., Hollinwood, near Chesterfield.—A brochure entitled "Truth is Stronger than Fiction," dealing with cast iron water pipes.

Jones and Lamson Machine Company, 19, Water-lane, E.C. 4.—Brochures dealing with the "J. and L." flat turret lathe and the 24in. "Fay" automatic lathe.

United Steel Companies, Ltd., 17, Westbourne-road, Sheffield.—A thirty-six-page booklet giving the constituent firms forming the group and details of their products.

Price's Patent Candle Company, Ltd., Battersea, S.W. 11.—A booklet containing a series of articles from *Gas and Oil Power* entitled "An Historical Survey of Diesel and Semi-Diesel Practice."

Sturtevant Engineering Company, Ltd., 147, Queen Victoria-street, E.C. 4.—Publication No. 1124 illustrating and describing a number of heating and ventilating plants the firm has installed.

G. and J. Weir, Ltd., Cathcart, Glasgow.—Catalogue Section 11, dealing with turbo-feed, turbo-electric and electro feeder pumps; also a thirty-page booklet on auxiliary plant for land installations, entitled "Reducing the Running Costs of Your Plant."

PERSONAL AND BUSINESS ANNOUNCEMENTS.

The Non-ferrous Die Casting Company, Ltd., of Nonferdica Works, North Circular-road, Cricklewood, N.W. 2, asks us to announce that it is not connected in any way whatsoever with the Non-ferrous Casting Company, of Birmingham.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
(1) Native	19/6 to 21/-
(1) Spanish	21/6 to 23/-
N.E. Coast—	
Native	18/- to 21/-
Foreign (c.i.f.)	21/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	4 1 0	—
No. 1 Foundry	4 0 6	—
No. 3 Foundry	3 18 0	—
N.E. Coast—		
Hematite Mixed Nos.	3 14 0	3 14 0
No. 1	3 14 6	3 14 6
Cleveland—		
No. 1	3 10 0	3 10 0
Silicious Iron	3 10 0	3 10 0
No. 3 G.M.B.	3 7 6	3 7 6
No. 4 Foundry	3 6 6	3 6 6
No. 4 Forge	3 6 0	3 6 0
Mottled	3 5 6	3 5 6
White	3 5 6	3 5 6
Midlands—		
(3) Staffs.—	(*Delivered to Station.*)	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 15 6	—
„ „ Foundry	3 19 6	—
(3) Northampton		
Foundry No. 3	3 15 0	—
Forge	3 11 0	—
(1) Derbyshire—		
No. 3 Foundry	3 18 6	—
Forge	3 14 6	—
(3) Lincolnshire—		
No. 3 Foundry	3 13 6	—
No. 4 Forge	3 9 6	—
Basic	—	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 8 6 (a) / 4 10 6 (b) / 4 14 0 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	10 5 0	9 15 0
Best	—	—
N.E. Coast—		
Iron Rivets	11 10 0	—
Common Bars	10 15 0	—
Best Bars	11 5 0	—
Double Best Bars	11 15 0	—
Treble Best Bars	12 5 0	—
Lancs.—		
Crown Bars	10 15 0	—
Second Quality Bars	9 15 0	—
Hoops	13 0 0	—
S. Yorks.—		
Crown Bars	11 0 0	—
Best Bars	11 10 0	—
Hoops	12 0 0	—
Midlands—		
Crown Bars	10 0 0 to 10 7 6	—
Marked Bars (Staffs.)	12 10 0	—
Nut and Bolt Bars	9 0 0 to 9 7 6	—
Gas Tube Strip	11 2 6	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates (Marine)	10 10 0	10 10 0
„ „ (Land)	10 0 0	10 0 0
Ship Plates, ¼in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ¼in.	9 0 0	8 15 0
Sheets (Gal. Cor. 24 B.G.)	12 15 0	12 5 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine)	10 10 0	—
„ „ (Land)	10 0 0	—
Joists	8 10 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	8 2 6	—
Soft Billets	6 17 6	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 10 0	—
Light Rails	8 15 0 to 9 0 0	—
Billets	6 15 0 to 9 10 0	—
Manchester—		
Bars (Round)	9 7 6	—
„ (Small Round)	8 0 0 to 8 2 6	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
„ (Lancs. Boiler)	9 17 6	—
Sheffield—		
Siemens Acid Billets	9 10 0 (basis)	—
Hard Basic	9 2 6 and 9 12 6	—
Intermediate Basic	7 12 6 and 8 2 6	—
Soft Basic	6 10 0	—
Hoops	9 15 0 to 10 0 0	—
Soft Wire Rods	8 0 0	—
Midlands—		
Small Rolled Bars	8 0 0 to 8 15 0	—
Billets and Sheet Bars	6 0 0 to 6 12 6	—
Galv. Sheets, f.o.b. L'pool	11 17 6	—
Sheets (30 W.G.)	16 7 6	—
Angles	8 7 6	—
Joists	8 10 0	—
Tees	9 7 6	—
Bridge and Tank Plates	8 17 6	—
Boiler Plates	9 12 6	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	18/3 to 18/6
Block Tin (cash)	159 2 6
„ (three months)	151 15 0
Copper (cash)	57 17 6
„ (three months)	57 15 0
Spanish Lead (cash)	18 10 0
„ „ (three months)	18 10 0
Spelter (cash)	17 2 6
„ (three months)	17 15 0
Manchester—	
Copper, Best Selected Ingots	60 5 0
„ Electrolytic	62 0 0
„ Strong Sheets	92 0 0
„ Tubes (Basis Price), lb.	0 1 0½
Brass Tubes (Basis Price), lb.	0 0 11½
„ Condenser, lb.	0 1 1½
Lead, English	20 0 0
„ Foreign	18 7 6
Spelter	17 5 0
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	3/1 per lb.	
Ferro Tungsten	2/10 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 12 6	7/-
„ „ 6 p.c. to 8 p.c.	£22 10 0	7/-
„ „ 8 p.c. to 10 p.c.	£22 0 0	7/-
„ „ Specially refined		
„ „ Max. 2 p.c. carbon	£33 10 0	10/-
„ „ „ 1 p.c. carbon	£38 0 0	13/6
„ „ „ 0·70 p.c. carbon	£40 0 0	15/-
„ „ „ carbon free	11d. per lb.	
Metallic Chromium	2/7 per lb.	
Ferro Manganese (per ton)	£11 15 0 for home	
„ „ „	£11 0 0 for export	
„ Silicon, 45 p.c. to 50 p.c.	£11 10 0 scale 5/- per unit	
„ „ 75 p.c.	£19 0 0 scale 7/- per unit	
„ Vanadium	12/9 per lb.	
„ Molybdenum	4/2 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£170 to £175	
Ferro Cobalt	9/6 per lb.	

FUELS.

SCOTLAND.

(*Prices not stable.*)

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	12/6
„ „ Ell	14/-
„ „ Splint	16/- to 16/9
„ „ Trebles	12/-
„ „ Doubles	11/3
„ „ Singles	10/9
Ayrshire—	
(f.o.b. Ports)—Steam	13/3
„ „ Jewel	16/-
„ „ Trebles	12/6
Fifeshire—	
f.o.b. Methil or Burntisland—Steam	10/3 to 12/9
Screened Navigation	16/6
Trebles	12/- to 12/6
Doubles	11/- to 11/6
Singles	10/9
Lothians—	
(f.o.b. Leith)—Best Steam	12/3
Secondary Steam	12/-
Trebles	11/-
Doubles	10/9
Singles	10/9

ENGLAND.

(8) N.W. Coast—	
Steams	21/6 to 23/-
Household	36/- to 51/-
Coke	22/- to 22/6
Northumberland—	
Best Steams	13/6
Second Steams	12/-
Steam Smalls	10/- to 10/6
Unscreened	13/-
Household	25/- to 37/-
Durham—	
Best Gas	15/9
Second	13/3 to 13/6
Household	25/- to 37/-
Foundry Coke	26/- to 29/-

Sheffield—	Inland.	
Best Hand-picked Branch	25/- to 26/6	—
Derbyshire Best Bright House	20/- to 22/-	—
Best House Coal	19/- to 20/-	—
Screened House Coal	17/- to 19/-	—
„ „ Nuts	15/- to 17/-	—
Yorkshire Hards	14/6 to 16/-	—
Derbyshire Hards	14/6 to 16/-	—
Rough Slacks	8/6 to 9/-	—
Nutty Slacks	7/- to 8/-	—
Smalls	3/- to 5/-	—
Blast-furnace Coke (Inland)	15/6 on rail at ovens	
Furnace and Foundry Coke (Export), f.o.b. 19/6 to 20/-		

(9) SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Smokeless Large	20/-
Second Smokeless Large	18/9 to 19/9
Best Dry Large	18/6 to 18/9
Ordinary Dry Large	17/6 to 18/-
Best Black Vein Large	18/3 to 18/6
Western Valley Large	18/- to 18/3
Best Eastern Valley Large	17/9 to 18/-
Ordinary Eastern Valley Large	17/6 to 17/9
Best Steam Smalls	13/3 to 13/9
Ordinary Smalls	12/6 to 13/-
Washed Nuts	17/- to 20/6
No. 3 Rhondda Large	20/6 to 21/-
„ „ Smalls	15/6 to 16/-
No. 2 „ Large	17/- to 17/3
„ „ Through	16/- to 16/6
„ „ Smalls	14/- to 14/3
Foundry Coke (Export)	30/- to 37/-
Furnace Coke (Export)	25/- to 27/6
Patent Fuel	22/- to 22/6
Pitwood (ex ship)	25/6 to 25/9
Swansea—	
Anthracite Coals:	
Best Big Vein Large	35/- to 37/6
Seconds	28/- to 32/-
Red Vein	23/6 to 27/6
Machine-made Cobbles	41/6 to 45/-
Nuts	40/- to 46/-
Beans	24/6 to 27/6
Peas	19/6 to 20/6
Breaker Duff	10/- to 10/6
Rubbly Culm	10/9 to 12/-
Steam Coals:	
Large	19/6 to 20/6
Seconds	18/- to 19/6
Smalls	12/6 to 13/6
Cargo Through	15/6 to 16/-

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate: Joists (minimum), 12/6; Ordinary Ship, Bridge, and Tank Plates and Sections, 10/- if home consumers confine purchases from associated British Steel Makers.

French Engineering Notes.

(From our Correspondent in Paris.)

The Steel Situation.

THE fact that steel prices are declining at a time when minimum prices have been fixed for export by the international sales comptoirs shows that something must be done to enable the Cartel and the comptoirs to exercise a more rigorous control over the trade if the present tendency towards a general backsliding is to be checked. Although home prices are not regulated by the international organisation, they are, nevertheless, affected by the belief that some foreign makers are offering concessions upon the agreed minimum terms for export business, and if the agreement cannot be adhered to under present conditions, the outlook is obviously unsatisfactory. Confidence in the operation of international comptoirs is weakening. It is felt that there should be only one comptoir under the direct control of the Cartel, but it is difficult to get all the producing countries to agree to this, although the situation has now become so precarious that producers will probably be amenable to any arrangement that will maintain prices rather than let the steel industry backslide with the risk of its getting beyond recovery. A meeting is being held in Paris this week to continue negotiations for the renewal of the Cartel and to decide upon the future organisation of the comptoirs.

Higher Costs.

The steel consumption in this country is capable of increasing largely, and in view of the public works being put in hand, French manufacturers believe that they will not suffer to the same extent as those elsewhere from the general trade decline. Nevertheless, the difficulties in the way of foreign trade are growing with the higher production costs, which, it is feared, will be further aggravated by the application of the social insurance scheme that will come into operation shortly and by threatened increase in railway rates. As a temporary expedient, to enable the franc to recover from its abysmal slump four years ago, the State imposed a tax of from 5 to 10 per cent. upon the carriage of goods and of 32·5 per cent. on passenger fares. The reasons for those taxes no longer exist, but the Government has so far refused to alleviate this heavy burden on railway users, except in a few cases, such as the removal of the tax on the carriage of goods for export. The reports of all the railway companies show that losses were sustained last year through the increasing working costs, and the companies declare that there is no alternative but to raise the railway rates still further, or to secure from the State a suppression or reduction of the taxes.

Paris Water Supply.

As the time approaches for settling the claim of Paris to draw a million cubic metres of water a day from the Vals de Loire, the local opposition to the scheme is becoming more pronounced. An important meeting has been held at Orleans at which were represented all the districts interested. Monsieur Sentenac, chief engineer of the Paris Water Department, explained that Paris had utilised all the sources available, and that it had no alternative but to follow the example of Lyons and other towns and pump the subterranean water from the sand. Paris, he said, would adhere strictly to the recommendations of the Commission which had been appointed to investigate the possible effects of the withdrawal of such a large volume of water from the Vals de Loire. Reservoirs would be constructed for the storing of water which would be returned to the Loire, if necessary. Monsieur Sentenac reminded the meeting that the Loire was public property, and that Paris had the right to draw supplies therefrom, if authorised to do so by Parliament.

Exhibition Constructions.

Except in the Indo-Chinese section of the International Colonial Exhibition to be held in the Bois de Vincennes outside Paris next year, little has been done with the construction of pavilions, but what has already been accomplished affords some idea of the methods being employed for the erection of temporary buildings. The most imposing of them is a full-size reproduction of the famous Angkor Temple in Annam. Its vast dimensions and great height suggest a particularly massive construction, but it is built entirely of timber, and the way in which the superstructure and the weight of plaster have been supported is an achievement. All the details of the temple's decorations are faithfully reproduced. Timber is used as a support for the plaster in all the oriental monuments, and the plaster is laid on crossed wires forming meshes, at the corners of which are moulded hard cement star-shaped projections, which give a good hold for the rough-cast plaster. The galleries, which are to contain colonial products and works of art, are built of light angle steel sections on which boards will be laid inside and out. Steel is being largely employed for buildings that are other than purely decorative. Reinforced concrete is not used to any great extent except for foundations.

Pile Extraction.

For the widening of the Concorde Bridge in Paris a part of the embankment had to be removed for the construction of an abutment in masonry, and sheet piling was driven in to prevent movements of the soil and also to avoid an infiltration of subterranean water. Now that the abutment is completed, the sheet piles are being withdrawn by means of a steam crane and a vibrator, this latter consisting of a cylinder containing a pneumatic hammer and suspended freely from the cable. On the axis supporting the vibrator are two plates carrying at their lower extremities an axis with plates bolted to the top of the pile to be withdrawn. While the cable exerts a tension on the pile, the latter is subjected to vibration by the pneumatic hammer through the top axis and the side plates.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

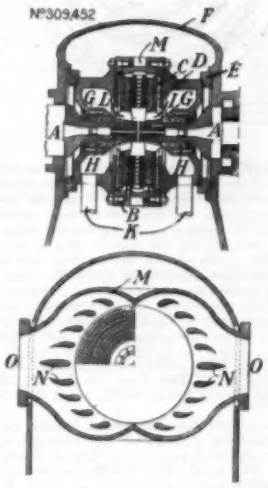
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

TURBINE MACHINERY.

309,452. April 10th, 1929.—RADIAL FLOW TURBINES, *The Brush Electrical Engineering Company, Ltd., of Falcon Works, Loughborough, Leicester.*

This invention relates to radial flow turbines, working with back pressure, and the purpose of the invention is to improve the design of such a turbine, especially as regards the exhaust of steam from the machine. The turbine is of the well-known double rotation type with two shafts A rotating in opposite directions and with two discs B. Labyrinth packing is provided at C for packing against the walls D and fastening rings which

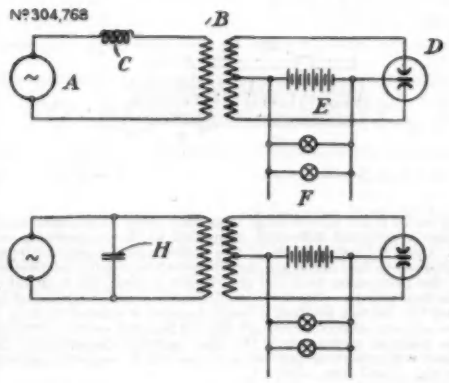


permit of expansion are provided at E. Between the chambers G and the turbine shafts there are labyrinth packings H. The steam inlet pipes K lead the steam to the distribution chambers G, and from these chambers the ports L leads to the central space of the blading system. The walls of the two steam distribution chambers are united with each other by an inner turbine casing M, and stays N contribute to conduct the steam towards the outlets by giving the least possible resistance to the flow. There are two exhausts O diametrically opposed.—*April 10th*, 1930.

DYNAMOS AND MOTORS.

304,768. January 12th, 1929.—ELECTRIC TRAIN LIGHTING SYSTEM, C. Lorenz Aktiengesellschaft, of 1, Lorenzweg, Berlin-Tempelhof, Germany.

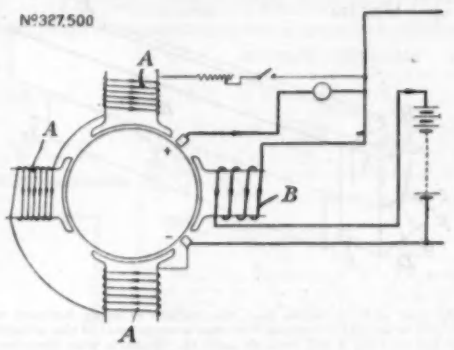
With a view to reducing the maintenance of direct current generators used for train lighting, it is proposed to use an alternating current machine and to rectify the current so that it may



be used for charging a battery. The generator A may produce current of from 200 to 1000 cycles and works without a rotor winding. It is connected to the primary winding of a transformer B through a choke coil C. D is the rectifier, E the battery and F the lamps. The choke coil C serves for regulating the generator voltage. In the lower illustration the choke coil is replaced by a condenser H.—*April 10th*, 1930.

327,500. February 4th, 1929.—ELECTRIC BATTERY CHARGING SYSTEMS, The English Electric Company, Ltd., of Queen's House, 28, Kingsway, London, W.C. 2; and Wilfrid Donnelly, of 262, Hornby-road, Blackpool, Lancashire.

This invention relates to electric battery charging systems employing for charging purposes a variable-speed generator, but the particular application to which the invention is most suited is in connection with electric traction employing an internal combustion prime mover on the vehicle, and known as Diesel or petrol-electric power transmission. In this case various engine speeds are necessary, and battery charging is usually done by a separate generator driven by the main engine. To be of any practical value in maintaining the battery always fully charged, charging must take place over a very wide range of engine speeds, and the invention relates to a type of generator which enables that to be done. Normal shunt windings A are provided on three of the poles, and the remaining pole is wound with an opposing series winding B carrying the battery charging current only. If it is desired that charging shall take place from, say, half engine speed to full speed, the shunt windings are proportioned to give battery terminal voltage at half speed, when the generator will float and there will be no flux due to the series winding on the pole B. This pole will then be a weak consequent pole of the same polarity as the pole diametrically opposite. This voltage will then be somewhat more than 75 per cent. of the voltage which the generator would have if provided with normal shunt windings on all four poles. At full speed the ampère turns due to the charging current flowing through the series winding B will be about equal to the normal ampère turns

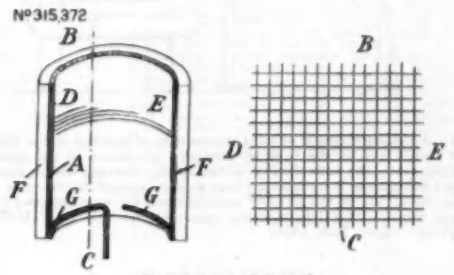


due to all the shunt windings A on each of the other three poles, but as the pole B is of reversed polarity the resultant effective flux for the generator will be that of two poles only, or two-thirds that at half speed; but the speed being double, the voltage will be about 30 per cent. higher or sufficient for a fully charged battery. Under these conditions the generator has three poles of one polarity and one of the opposite polarity, the whole field flux which traverses the armature passing between this one pole and the other three, between which it is distributed. The net result is a possible variation between floating at half speed to full charging rate on a fully charged battery at full speed.—*April 10th*, 1930.

TRANSFORMERS AND CONVERTERS.

315,372. July 12th, 1929.—ELECTRIC TRANSFORMERS, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C. 2.*

This specification describes a metallic screen for equalising the distribution of the electrostatic field in high-tension transformers. A cylinder consisting of two parts is mounted on the magnetic circuit. The portion A is composed of a mixed fabric consisting of wires extending in the direction B C and textile threads in

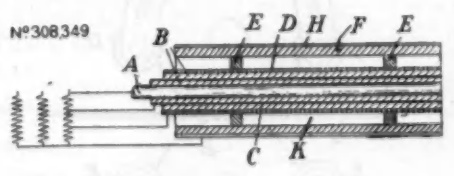


the direction D E. The other portion F of the cylinder is formed of an insulating supporting material, such as cloth, paper, or cellulose, the whole being impregnated with synthetic resins polymerised at high temperature. The wires are not the centre of any electromotive force, as they are insulated from each other. An open circuit G equalises the potential between all the wires and forms the earth connection.—*April 10th*, 1930.

TRANSMISSION OF POWER.

308,349. March 13th, 1929.—HIGH-TENSION ELECTRIC CABLES, Felten and Guilleaume Carlswerk Action-Gesellschaft, of Köln-Mülheim, Germany.

The cable described in this specification is for very high voltages. The copper conductor A is surrounded by insulation B consisting of layers of paper soaked with oil and resin. In these layers conducting layers C may be inserted, and the insulation is



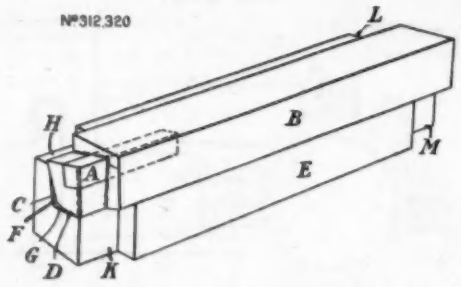
surrounded by a metal sheath D. The cable thus formed is held by insulating distance pieces E in the tube F, over which a binding wire H may be wound. The space K may be filled with oil or air under pressure or with compound. A voltage is applied to the lead sheath and in some cases on the conducting insertion C by a tapping taken from a transformer as shown. The outer metallic sheaths H and F would in most cases be connected together at short intervals.—*April 10th*, 1930.

MACHINE TOOLS AND SHOP APPLIANCES.

312,320. May 22nd, 1929.—METAL CUTTING TOOLS, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C. 2.*

This invention relates to metal cutting tools and more particularly to tools comprising a shank of one material and a tool bit of another material. A tool bit which is an alloy or metal composition consisting largely of tungsten carbide but containing an appreciable amount of cobalt is indicated at A. The amount of cobalt employed may vary from about 3 to 25 per cent. of the content of the alloy. The shank B consists of metal which is cast around the bit A, the side C of the tool being inclined to the bottom D at an angle slightly greater than 90 deg. Ordinary

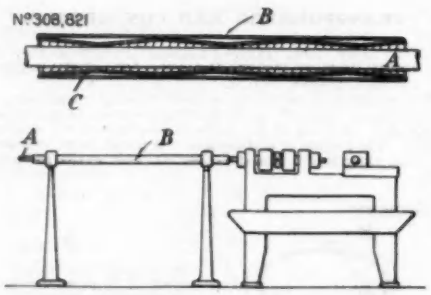
gray cast iron gives particularly good results. The bit is embedded in the shank and may extend into it for varying distances depending on the size of the bit employed. The cast iron shank adheres very firmly to the alloy bit and does not become separated therefrom even at extremely high temperatures. In operation, if the shank consists of gray cast iron, it is advisable to employ a tool steel supporting member E. The supporting member has approximately the same length as the shank B and is cut away to provide two surfaces F and G which are inclined to each other at an angle equal to the angle produced by the



adjacent surfaces of the tool, the surface G being inclined, as shown, towards the surface F so that a component of the pressure on the tool bit A will tend to force the shank in that direction, *i.e.*, against the surface F. The holder is cut away, as indicated at H and K, to permit proper operation of the cutting tool. The opposite ends of the holder may be cut away in a similar manner at L and M so that the holder may be employed with tools having the cutting portion either on the right-hand or left-hand side of the shank.—*April* 10*th*, 1930.

308,821. March 28th, 1929.—Turning Lathes, Hermann Hahn and Oskar Hahn, trading as Index Werke, Hahn & Kolb, of Esslingen a/N, Germany.

This invention relates to guide sleeves or tubes for lathes which are adapted to accommodate a portion of the length of the rotating work. The work rod A is arranged in the guide tube

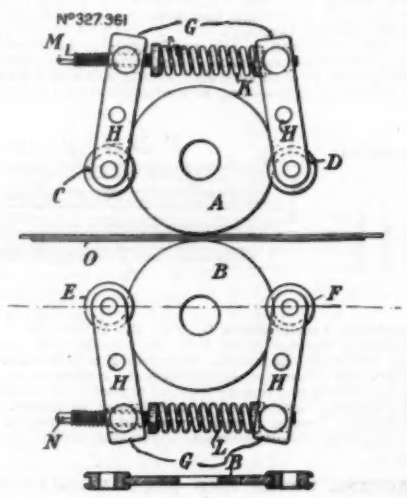


B. A helical spring C of hard-drawn wire is inserted in the tube B and is held in the tube by friction. As shown in the upper illustration, the convolutions of the spring decrease and increase and the largest convolutions bear tightly against the interior of the tube, whilst the smaller convolutions act as a support for the work. The intermediate convolutions act as a buffer spring.—*April* 10*th*, 1930.

MISCELLANEOUS.

327,361. July 11th, 1929.—Electrical Resistance Welding with Rolling Electrodes, E. A. Rosengrens Kassaskapsfabriks Aktiebolag, Göteborg, Sweden.

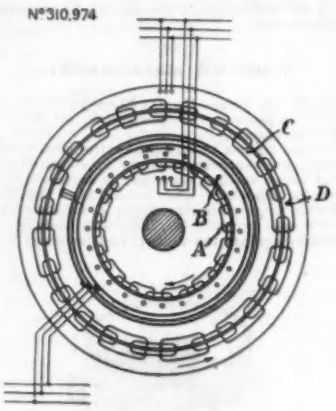
The rolling electrodes for resistance welding are subjected to substantial wear and tear of the parts which make contact with the piece to be welded, thereby causing the contact surface between the electrode and the piece to be welded to vary in dimensions with a corresponding variation of the temperature of the piece to be welded and the character of the weld. The contact surface tends to become larger, so that the temperature falls and the voltage of the electrical current once properly



set has to be successively increased from time to time. Moreover, after a relatively short time the electrodes have to be reshaped which involves a loss of time and material. The object of the present invention is to maintain the true form of the electrodes. A and B indicate the electrodes and C, D, E and F grooved circular rollers bearing thereon. These rollers are mounted in the ends of arms G pivoted on shaft-journals H, and between the other arm ends are mounted compressed springs K, L, which press the rollers against the electrodes. M and N indicate screws for adjusting the springs, O is the material to be welded.—*April* 3*rd*, 1930.

310,974. May 4th, 1929.—Electrical Frequency Changers, *International General Electric Company, Incorporated, of* 120, *Broadway, New York.*

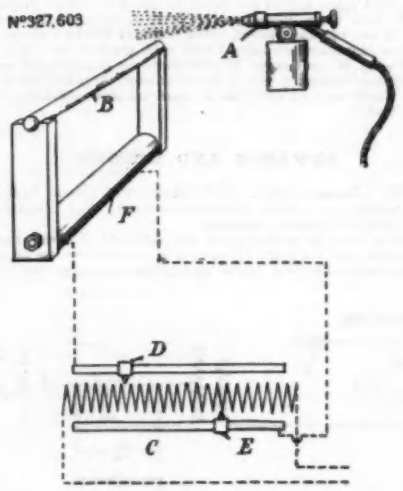
The driving motor of the frequency changer described in this specification comprises an inner stator having a winding A supplied with current at line frequency. The rotor is in the form of an annulus and rotates round the inner stator. It is provided with an internal bar winding B and external phase windings C. The phase windings are connected to slip rings from which current having a frequency different from that of the supply can be taken. Outside the rotor there is an outer stator having phase



windings D supplied from the same system as the windings A in such a manner that the fields set up by the windings A and D rotate in opposite directions. If, for example, the inner stator winding has four poles and the outer stator winding six poles, then with a line frequency of 50 cycles the rotor will revolve at about 1500 revolutions per minute and a current having a frequency of 125 cycles can be taken from the slip rings. By suitably selecting the number of poles for each winding the desired frequency ratio may be obtained. Further, by arranging the winding of the phase coils so that groups of poles may have their polarity changed, in known manner, currents of different frequencies can be provided for.—*April* 10*th*, 1930.

327,603. May 1st, 1929.—Detecting Cracks in Steel Parts by Magnetism, Walter Leonard Lorkin, Ernest Edgar Daglish and Henry Bevan Swift, all of 2-3, Norfolk-street, Strand.

In accordance with this invention, cracks are detected in steel parts by passing a magnetic flux through the part to be tested, so that magnetic polarity is formed across the edges of any crack that may exist. Iron powder is then sprayed over the part under test by means of a spraying pistol A, operated by compressed air, the part B under test being magnetised from a suitable source controlled by a potentiometer C. When the



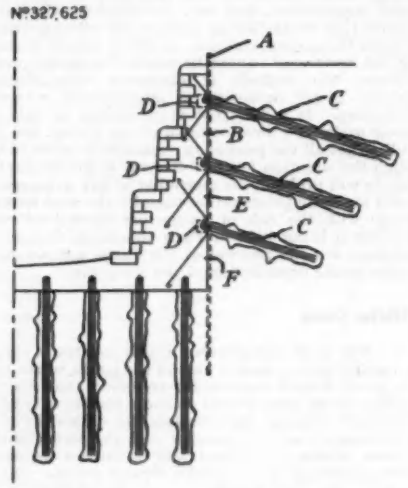
sliders D, E are moved away from each other in opposite directions, a potential difference is applied to the magnetising coil F. Upon the return of the sliders to the central position current will cease to flow in the coil, but there will be residual magnetism in the part under test and this would prevent the removal of the iron powder. If, however, the sliders are carried slightly past the central position a small current is caused to flow in the opposite direction through the coil B and it serves to remove the residual magnetism. The iron powder ejected from the pistol will adhere to any crack across which magnetic polarity exists.—*April* 10*th*, 1930.

317,056. August 8th, 1929.—Methods of Manufacturing Electric Condensers, Elektrizitäts-Aktiengesellschaft Hydrawerk, of Windscheidstrasse 18, Berlin, Charlottenburg, Germany.

This invention relates to the manufacture of wound electrical condensers. Hitherto, in order that they may have the desired capacity, the dimensions of such condensers have been determined empirically, as, for example, by calculating the length of foil or the number of turns required. Such methods, however, take no account of the varying thickness of the materials to be used, and it is the object of the invention to provide a method whereby this disadvantage can be overcome. To this end, the capacity of the condenser is measured electrically during winding in order to indicate when the winding operation has been carried far enough. When the desired capacity is indicated on the measuring instrument the winding may be stopped independently of the number of turns or the length of foil which has been used. An alternating voltage is applied across the condenser layers while an ammeter in the circuit indicates the actual charging current. Assuming a constant voltage and neglecting the ohmic resistance the ammeter will indicate a value proportional to the capacity of the winding. The winding operation is proceeded with until the ammeter indicates a predetermined current corresponding to the capacity required. If desired, apparatus may be provided whereby when the current strength reaches a predetermined value an indicating device or mechanism for automatically stopping the winding operation is operated. For example, a relay may be employed for this purpose. In addition to stopping the winding apparatus the relay may also lock it automatically in the position in which it has stopped.—*April* 10*th*, 1930.

327,625. May 23rd, 1929.—Process for the Construction of Docks, Locks and like Structures, John Fillans Barr, of Killineer House, Drogheda, County Louth, Irish Free State, and August Wolfsholz, of 2B, Via Aguggiari, Varese, Italy.

This invention relates to a process for the construction of docks, locks and similar structures, in which a large site has to be excavated for the accommodation of the structure. The object of the process is to enable the work of excavation to be carried out in stages and to avoid the necessity of extensive cross timbering. The whole site is first enclosed in sheet



piling sections A and then a horizontal layer down to the point B is removed over the whole site. A hole is then burnt in selected sheet piling sections and a pressure pile C is forced behind the sections, thus binding them to the adjacent soil. The reinforcements of the pressure piles C are connected to a longitudinal steel beam encased in concrete D to support the sheet piling. A further layer down to the point E is then excavated and the process is repeated. Excavation is then carried out to the point F and the process repeated and so on until the full depth required is reached. After the full depth has been reached the concrete structure is built up, its reinforcing members extending behind the concrete beams D.—*April* 10*th*, 1930.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

Institution of Electrical Engineers: Scottish Centre.—In the Hall of the Technical College, Bell-street, Dundee. The Twenty-first Kelvin Lecture, entitled "Some Recent Advances in the Electron Theory of Metals," by Mr. R. H. Fowler, F.R.S. 7.30 p.m.

Keighley Association of Engineers.—At the Queen's Hotel, Keighley. Annual general meeting, President's address. 8 p.m.

Royal Institution of Great Britain.—21, Albemarle-street, W. 1. Discourse, "The Great Barrier Reef of Australia," by Mr. C. M. Yonge. 9 p.m.

WEDNESDAY, MAY 21ST.

Royal Microscopical Society.—In the Great Hall, King's College, Strand, London, W.C. 2. An exhibition and demonstration of the latest types of metallurgical instruments and apparatus will be opened. Professor Nils E. Svedelius (Upsala) will deliver a communication on "The So-called Fresh Water Lithoderma." Scientific communications and discussion on "Recent Advances in Current Research and Practice in Microscopic Metallography." 3 p.m. to 10 p.m.

FRIDAY, MAY 23RD.

Royal Institution of Great Britain.—21, Albemarle-street, W. 1. Discourse, "Some Scientific Instrument Makers of the Eighteenth Century," by Mr. R. S. Whipple. 9 p.m.

FRIDAY, MAY 30TH.

Royal Aeronautical Society.—At the Rooms of the Royal Society of Arts, John-street, Adelphi, W.C. 2. "The Development and Progress of Aircraft Engines," by Mr. H. R. Ricardo. 6.30 p.m.

CONTRACTS.

The Hunslet Engine Company, Ltd., of Leeds, has received an order from the Crown Agents for the Colonies for one 2–6–2 type locomotive, metre gauge, with outside cylinders, 15in. by 22in., for the Tanganyika Railway.

Robert Stephenson and Co., Ltd., of Darlington, and 25, Victoria-street, Westminster, London, S.W. 1, have received an order from the London and North-Eastern Railway Company for twenty locomotive boilers, class J 39, superheated, with copper fire-boxes and steel tubes.

Yarrow and Co., Ltd., Scotstoun, Glasgow, have received orders for boilers with superheaters, &c., from H.M. Dockyard, Devonport North, two units (repeat orders); Heera Mills, India, three units; Geertruidenberg Power Station, two units, 570 lb. (third repeat order); Nijmegen Power Station, two units (repeat order); Japanese Government, one boiler, 1000 lb.; Savoy Hotel, London, one boiler; Ellangowan Paper Mills, one unit; J. Lyons and Co., Ltd., Cadby Hall, one unit (second repeat order).